eosens TS3
High-Speed Handheld Camera

User Manual

2013-3

110S-3000M

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Contact

Mikrotron
Mikrocomputer, Digital- und Analogtechnik GmbH
Landshuter Str. 20-22
D-85716 Unterschleissheim
Germany
email: sales@mikrotron.de

Chapter Summary

Chapter 1, TS3 Product Overview

The first chapter contains general information regarding the TS3 product family, common applications for which the camera is used, and the basic guide to the component parts of the camera. Look here for the names and locations of all camera controls and indicators.

Chapter 2, Getting Started

This chapter guides the user through the camera setup process from unpacking the camera to attaching, connecting, or installing the pieces necessary to begin using the camera: i.e. the power supply and/or battery, lenses, mass memory devices, etc., as well as optional devices such as triggers, monitors, PCs, etc.

Chapter 3, Camera Setup

This chapter is about learning to use the TS3 user interface and setting the camera up for use, including naming the camera and setting up the time. It also covers controls for the built-in LCD display, connecting with an external display, and connecting the TS3 to a computer network.

Chapter 4, Recording with the TS3

Chapter 4 covers the recording process from setting up the recording parameters to Arming and Triggering the camera. It also covers bit selection, image processing and saving the imagery in its different formats.

Chapter 5, Synchronizing Cameras

Cameras may be synchronized to external timing devices as well as to other cameras. This chapter tells you how to do it on the TS3.

Chapter 6, TS3 Web-Application

TS3 camera's Web-Application makes it easy to control the camera from virtually any device that can attach to a network and run a standard internet browser. No need to load any software! Chapter 6 walks you through the Web-App and how to control the camera, and capture and manage imagery with it.

Chapters 7 and 8, Fas*M*otion

Fas*M*otion is MIKROTRON proprietary camera control software for setting up and controlling the TS3 with a PC via GigE connection. Chapter 7 covers the setup portion. Chapter 8 covers recording with Fas*M*otion.

Appendices and Application Notes

Technical details are to be found in these sections. They include a glossary of terms, camera and sensor specifications, lens FOV vs. resolutions tables, an index, connector schematics, and back focus adjustment procedures, system optimization and much more.

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1 TS3 Product Overview

1-1 TS3 Product Description

The MIKROTRON eosens TS3 is a high-speed digital camera line with models capable of capturing high resolution 1280 x 1024 pixel images at 500 frames per second and smaller-resolution images at much higher frame rates. Recording image data at high frame rates makes it possible to play back high quality video sequences in slow motion, enabling the user a greatly enhanced ability to analyze events that occur much too quickly for human vision to perceive.

The TS3, with its many modes of operation, including its unique stand alone capabilities, and its high speed imaging performance, resolution and sensitivity, make it an excellent choice for many different applications. For ad hoc testing and troubleshooting, when setup time is precious, the TS3 comes through as a point and shoot camera. For multi-camera use or where the camera might be set up and left in mo e remote applications, its networking and master/slave capabilities come into play.

MIKROTRON high-speed cameras are used in hundreds of different industrial manufacturing sites to analyze motion in machinery and production line processes. Reduce jams, speed up line setup and changeovers, lower scrap and rejected material costs, and reduce downtime and maintenance expenses.

Hundreds of universities worldwide use MIKROTRON cameras for a variety of research studies. Animal locomotion, mechanical engineering, flow visualization, combustion studies, biomechanics & kinesiology, physics, chemistry, tensile testing, and more.

High-speed cameras are used to determine the effects of blasts on structures or vehicles or determine the actual firing times of blast holes and the nature of the rock movement. Delay detonators provide the timing blasts needed under specific blasting onditions. Blast holes firing the incorrect times reduce rock fragmentation, effect blast movement, and can increase blast vibrations

Military customers worldwide use high-speed video to design and test weapons, counter measure and defensive systems and components. High-speed cameras are key for testing projectiles for determining ballistics, detonics and fragmentation characteristics; in airborne stores separation; and in vehicle armor design testing materials and survivability.

1-2 TS3 Product Differentiation

MIKROTRON sells a number of different TS3 high-speed digital camera models. These cameras are offered in either monochrome or color with various high-speed digital image recording capability using a wide range of recording rates, sensor resolutions, and on-board memory options. The cameras comprise an 8-bit (mono) or 24-bit(color) pixel resolution for HiSpec models, while the TS3 models boast 10-bit (mono) or 24-bit (color) resolutions. All cameras are equipped with a standard C-mount lens mount, and 1/4-20 tripod mount. Additional lens mount options are available.

TS3 cameras support the following modes of operation

- Standalone operation The TS3's built in 7" LCD display, SSD, SD Card, or USB download, and battery power allow it to be fully functional without th connection o a host PC.
- Remote operation using MIKROTRON Web Application: With the Web Application, any host device with a common Web browser may be used to control the camera.

The TS3 camera housing is made of 100% machined aluminum with a hard black anodized finish. It is both attractive and extremely durable. LEMO connectors are used for critical power and Sync/ Trigger connections. An aluminum side panel door protects USB-OTG, HDMI, Gig-E, Sync/Trigger, and Power connectors as well as the SD Card slot when the camera is operating in stand alone mode. Power is supplied by an AC power adapter or a high-capacity Li-Ion battery.

Table 1-1: TS3100-L and TS3100-S Models

Camera	Max Resolution / Frame Rate	Standard Memory	Sensor Size	Optional Memory	Optional Solid-State Drive
TS3-100-L	(Std): 800 x 600 @1250 fps	4GB	14mm	8GB	64GB / 128GB / 256GB
TS3-100-S	(Full): 1280 x 1024 @ 500 fps	4GB	22.9mm	8GB	64GB / 128GB / 256GB

Table 1-2: Part Number Legend

TS3100XXXxxx

Component	Options	Examples
Drive (GB SSD)	None/ 064 / 128 / 256	
Memory (GB)	4 / 8	TS3100LC4 = Std. Resolution, Color , 4GB (no SSD)
Sensor (Mono/Color)	C / M	TS3100SM4 = Full Resolution, Mono , 4GB (no SSD)
Model	L / S	TS3100SM8064 = Full Resolution, Mono , 8GB with 64GB SSD

1-3 TS3 Controls, Indicators, and Connectors

Table 1-3: Camera Part Locations

Camera Part	Link to View
LED Indicators	“Figure 1-1: TS3 Back View” / “Figure 1-2: TS3 Front View”
Arm Button	“Figure 1-1: TS3 Back View”
Display Button	“Figure 1-1: TS3 Back View”
Menu Button	“Figure 1-1: TS3 Back View”
D-Pad (Directional Pad)	“Figure 1-1: TS3 Back View”
Trigger Button	“Figure 1-3: TS3 Top View”
ON/OFF Button	“Figure 1-3: TS3 Top View”
Strap Attachments	“Figure 1-3: TS3 Top View” / “Figure 1-5: TS3 Bottom View”
C-Mount	“Figure 1-2: TS3 Front View”
C-Mount Lock Screws	“Figure 1-3: TS3 Top View” / “Figure 1-5: TS3 Bottom View”
Lens Mount Holes	“Figure 1-3: TS3 Top View”
1/4-20 Tripod Mounts	“Figure 1-3: TS3 Top View” / “Figure 1-5: TS3 Bottom View”
USB Port	“Figure 1-3: TS3 Top View”
USB OTG Port	“Figure 1-4: TS3 Side View (Door open)”
SD Card Slot	“Figure 1-4: TS3 Side View (Door open)”
Gig-E Connector	“Figure 1-4: TS3 Side View (Door open)”
Sync I/O Connector	“Figure 1-4: TS3 Side View (Door open)”
HDMI Connector	“Figure 1-4: TS3 Side View (Door open)”
Power Connector	“Figure 1-4: TS3 Side View (Door open)”
Battery Door	“Figure 1-5: TS3 Bottom View”
Battery Door Latch	“Figure 1-5: TS3 Bottom View”
Battery Clasp	“Figure 1-5: TS3 Bottom View”

Figure 1-1: TS3 Back View Note: See “Appendix I: Physical Measurements” on page 89 for dimensions.

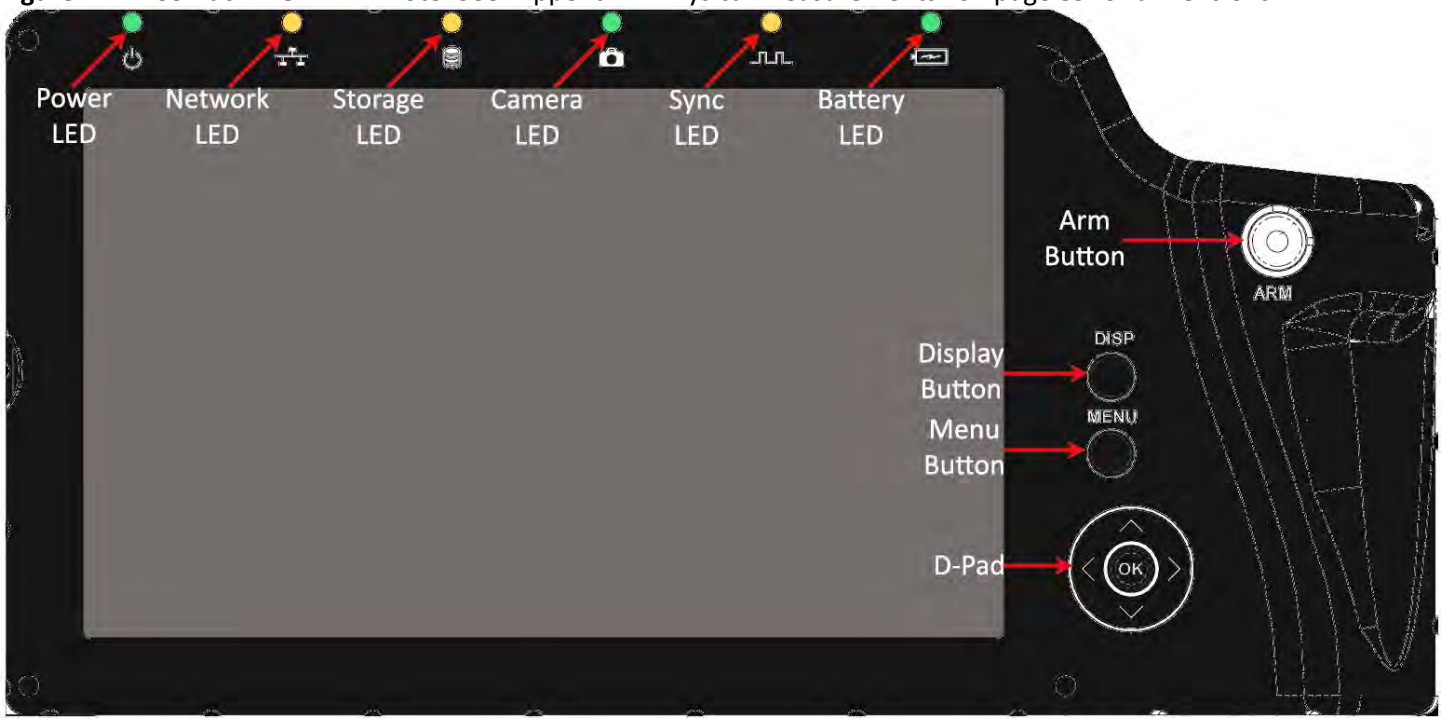


Figure 1-2: TS3 Front View

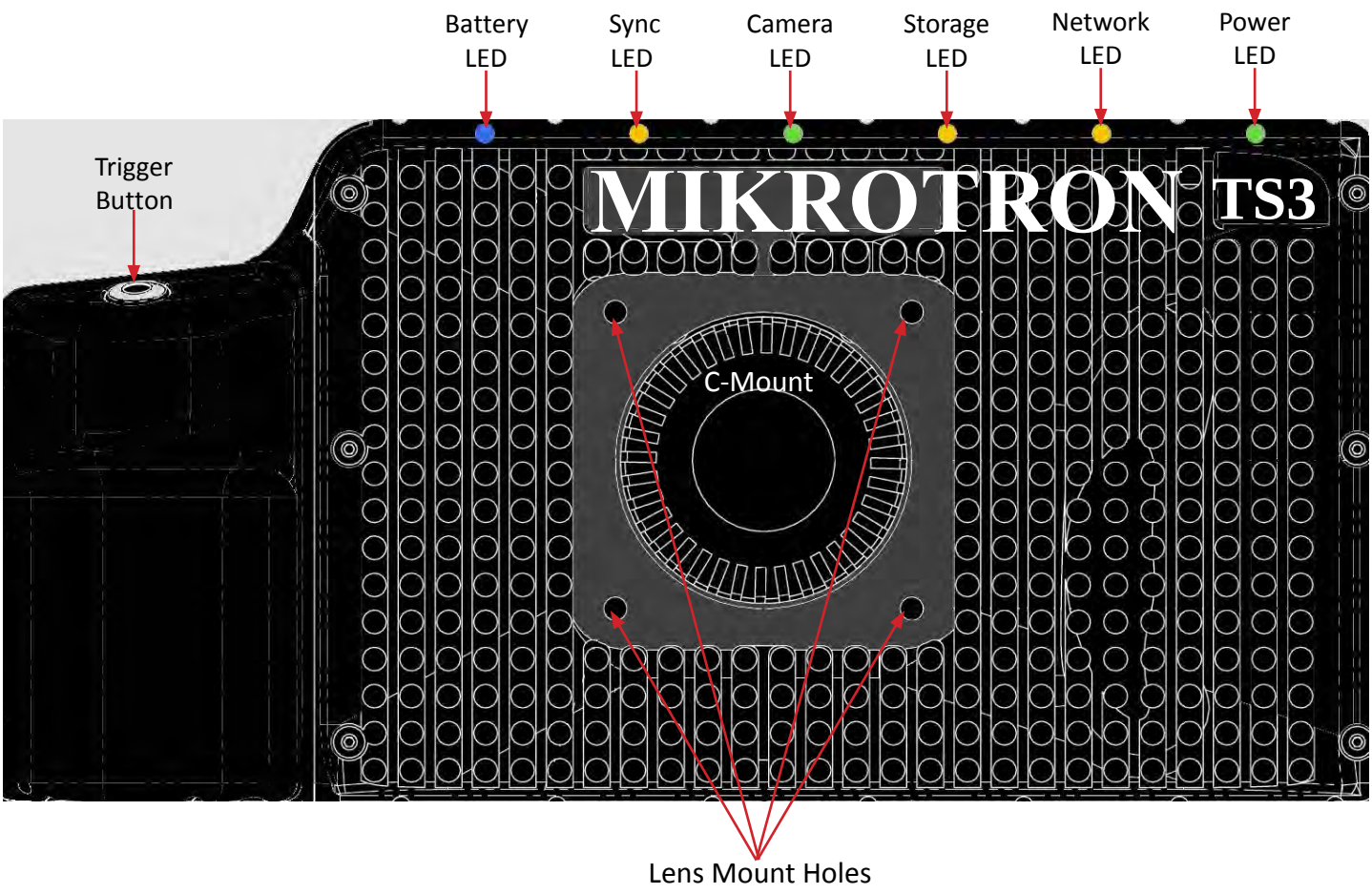


Figure 1-3: TS3 Top View

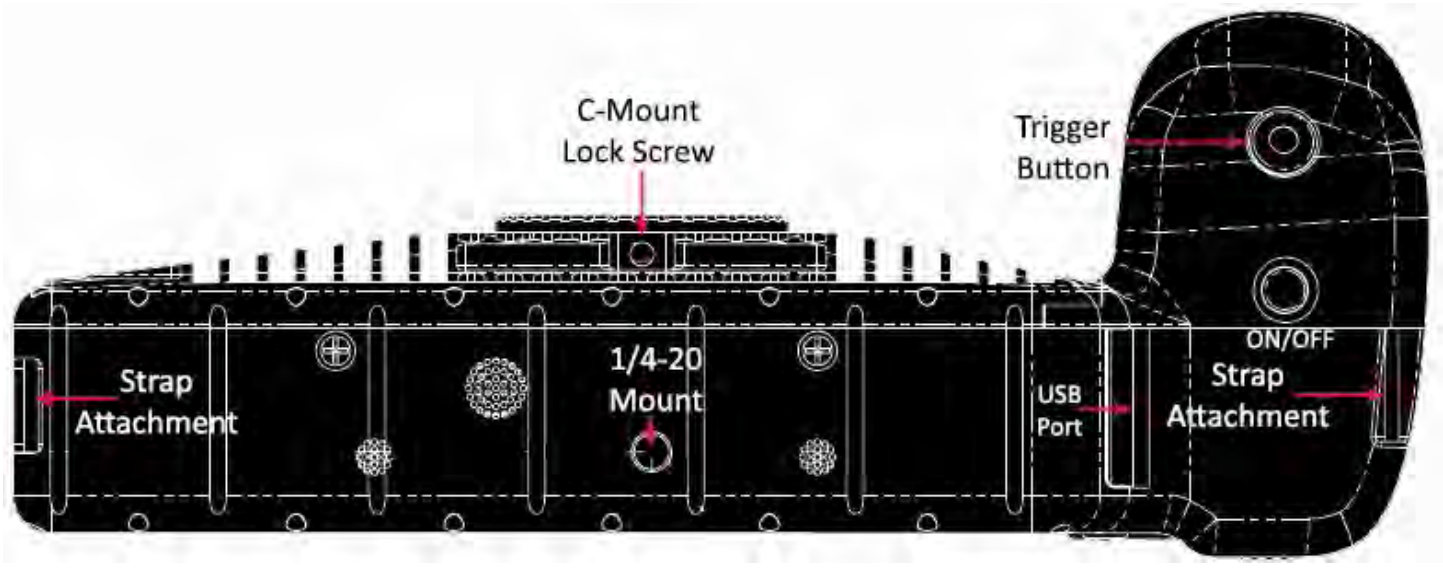


Figure 1-4: TS3 Side View (Door open)

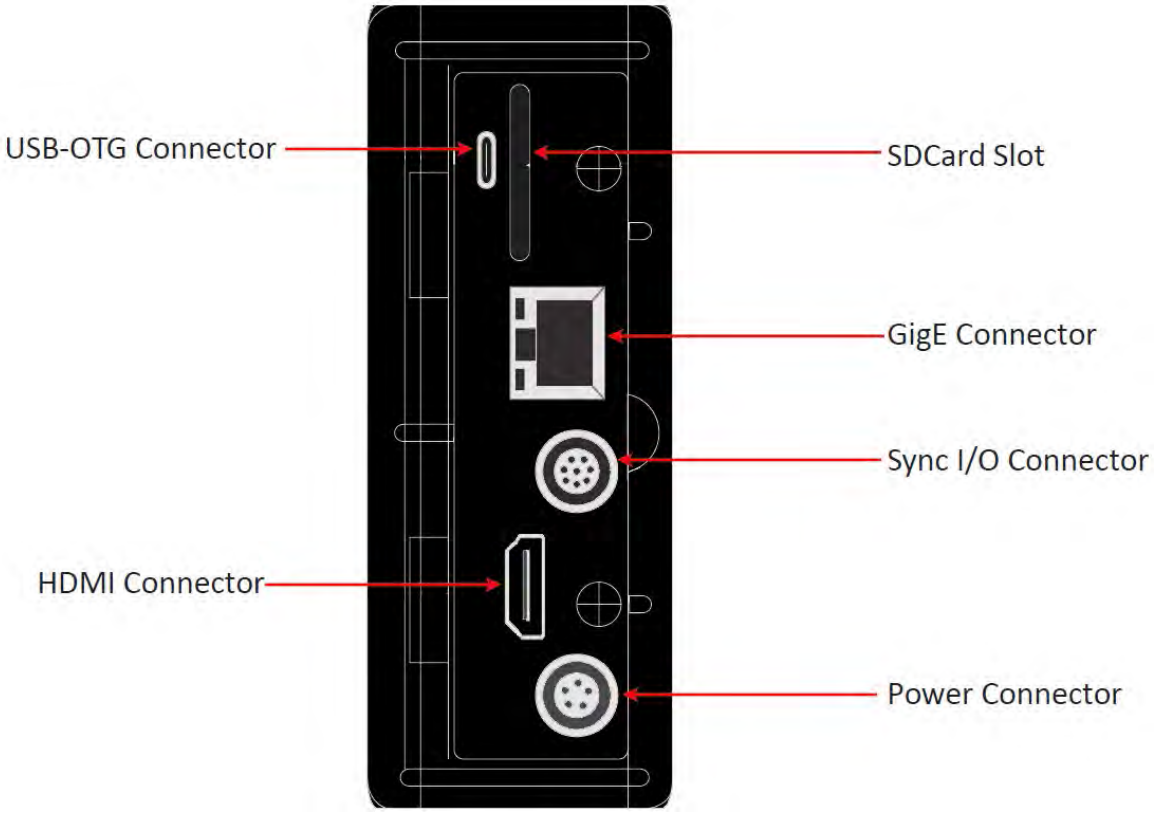
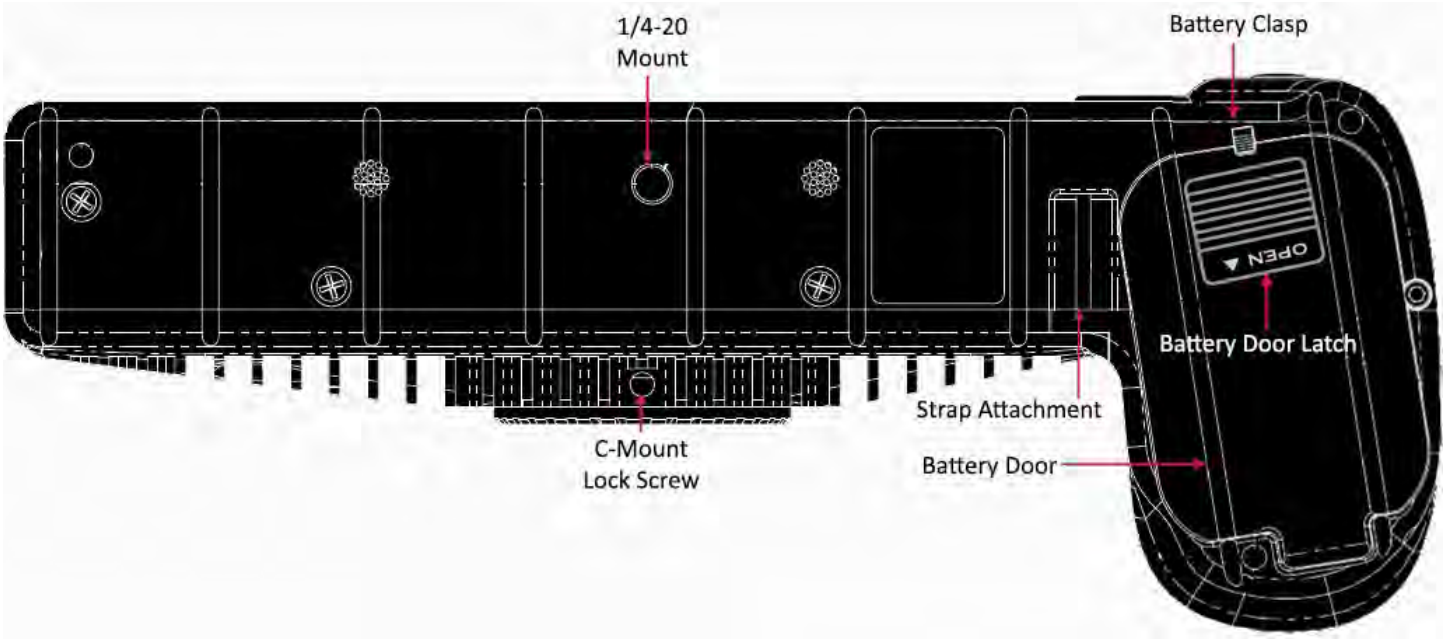


Figure 1-5: TS3 Bottom View



2 TS3 Getting Started

2-1 Unpacking the Camera

Table 2-1: Package Contents:

Part	STD	OPT	Part #
TS3 Camera	X		TS3100XXX
C-Mount (factory installed and adjusted on the camera)	X		
F-Mount (factory installed and adjusted on the camera)		X	1105-0200
DC Power Supply-- 110/220VAC, 50/60Hz, 12V @ 4.17A, with IEC 13 socket and 5-pin LEMO connector (no power cord included)	X		1105-0250
8 GB SDHC Card		X	1105-0270
16 GB SDHC Card	X		1105-0271
32 GB SDHC Card		X	1105-0272
I/O Cable--1.3 meter with 8-pin LEMO camera connector and BNC connectors for Sync-In, Sync-Out, and Trigger-In	X		1105-0401
Wireless Dongle		X	1105-0275
Documentation and Software (on thumb drive)	X		
Battery--Rechargeable Li-Ion 3.7V 15,600mAh (Battery comes fully charged from factory)	X		1105-0050
Hoodman 7” LCD Display Cover for glare protectio		X	1105-0330

MIKROTRON retails its cameras through independent distributors. MIKROTRON or its distributors can provide the accessory items required for camera operation according to each customer’s particular application needs.

2-2 Installing the Lens

The camera is shipped with a C-mount lens adaptor installed and adjusted at the factory. To install a C-mount lens, follow these steps:

1. Select a C-mount lens for use with the camera.

NOTE: There are many C-mount lens formats and focal lengths available. The 22.9mm diagonal sensor of the TS3100L is larger than the light circle produced by many C-mount lenses. This is especially true for wide angle lenses, but it is dependent on lens design and format. Vignetting (darkening at the edges of the image), will occur when the image on the sensor, the size and location of which is dependent on resolution and image to set, is not covered by the image circle of the lens. (See “Table 2-2: Lens Selection .)

2. Remove the lens receptacle cover from the camera’s C-mount. This is a cover that is installed at the factory to protect the camera optics and sensor from dust contamination

NOTE: Whenever threading lenses on or off the camera, face the camera lens down so that any contamination on the threads will tend to fall away from the camera rather than into it.

3. Thread the C-mount lens into the lens mount located in the front of the camera. DO NOT overtighten the lens! The lens should be “finger tight” only--just tight enough that you can adjust focus and aperture without unscrewing the lens.

NOTE: Limit the time between removal of the receptacle cover and installation of the lens. Dust could settle on the face of the sensor cover glass and degrade the image quality.

Table 2-2: Lens Selection

Resolution	Sensor Diagonal	Required Lens Format to avoid noticeable Vignetting	Field of View From 10M with 50mm Lens
1280 x 1024	22.9mm	1.3”	3.6 x 2.9M
1024 x 1024	17.5mm	1.3”*	2.9 x 2.9M
800 x 600	14mm	1”	2.2 x 1.7M
640 x 480	11.2mm	2/3”	1.8 x 1.3M
256 x 200	4.5mm	1/3”	.72 x .56M

*The 17.5mm diagonal @ 1024 x 1024 is slightly larger than the 16mm specification or 1” C-mount lenses. Many, but not all 1” format lenses will satisfactorily cover this resolution

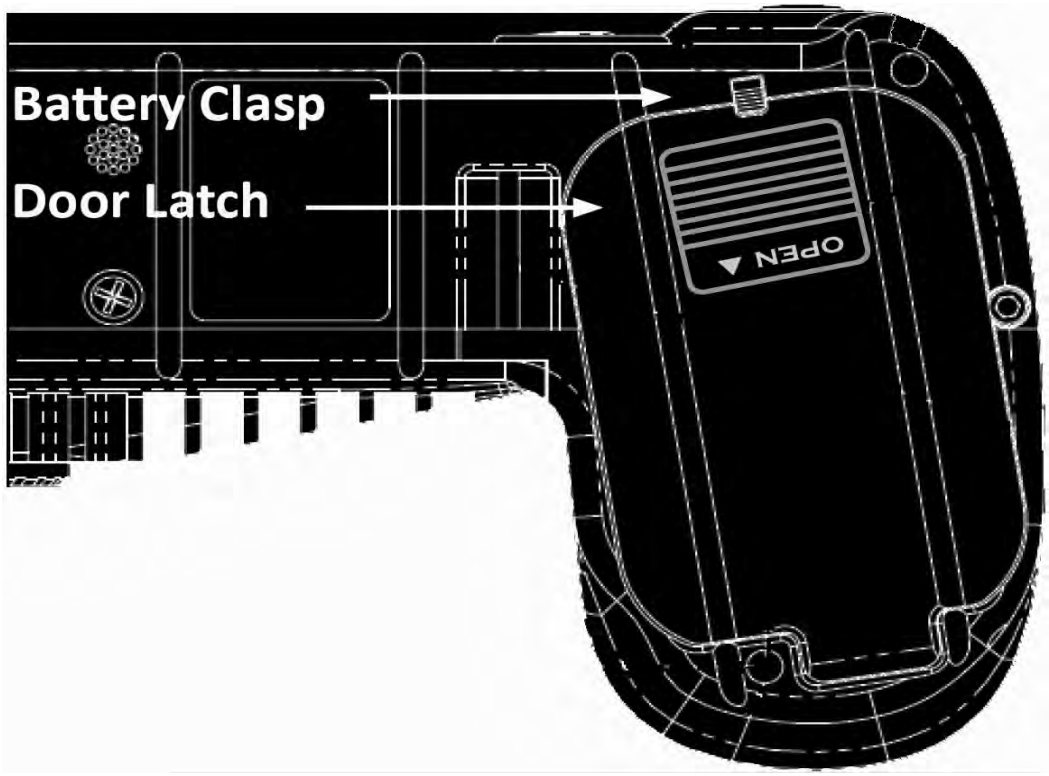
This table assumes that the images are centered (no custom offset applied). (See “Table 9-3: Resolutions, Rates, and Times” on page 79.)

Note: All F-mount lenses will easily cover the full 22.9m full resolution image plane.

2-3 Powering Up, Charging, and Power Down

The camera can be powered by its rechargeable 3.7V Li-Ion battery or the external 12V power supply. Both are included with the camera. The battery is fully charged at the factory and is shipped outside the camera to avoid accidental discharge. The battery door is located on the underside of the camera.

Figure 2-1: Battery Access Door



The Li-Ion battery will power the TS3 for up to several hours, depending on configuration and mode of operation

NOTE: When a new battery is installed, it must go through one complete discharge/recharge cycle to

calibrate its internal “gas gauge.” Until that time you will find that the % of charge shown on the lower right of the camera display as well as on any camera control software will not be correct. (See “Figure 2-2: Battery Charge Indicator on Status Bar” on page 9.)

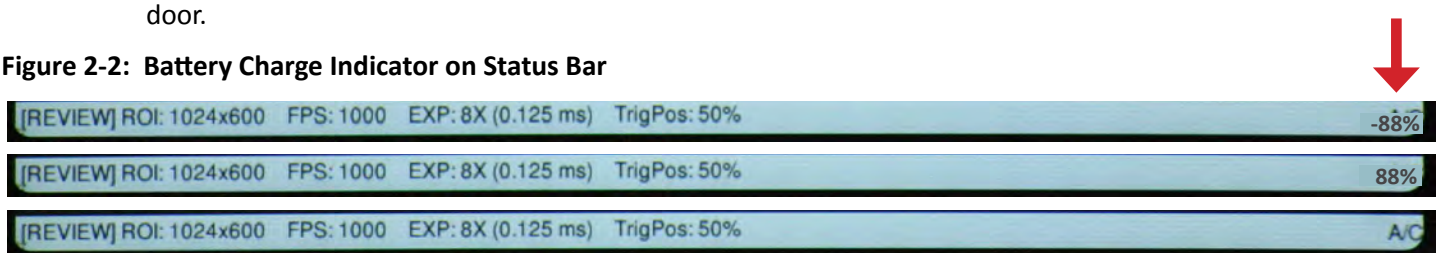
Removing the Battery

1. Turn the TS3 upside down to access the battery compartment.
2. Slide the battery door latch to the “open” position. The spring loaded door will open
3. Move the battery clasp away from the edge of the battery. (See “Figure 2-1: Battery Access Door”.)

Installing the Battery

1. Open the battery door (follow steps 1-2, above).
2. Look into the battery compartment and notice the connector at the bottom and the battery strap.
3. Position the battery strap within the compartment so that it has enough slack to accommodate the battery but will not bunch up when the battery is installed..
4. Orient the battery appropriately and slide it into the compartment.
5. With the battery seated properly in the compartment, the battery clasp will close, securing it in place.
6. Fold the loose end of the battery strap over the top of the battery and close the battery access door.

Figure 2-2: Battery Charge Indicator on Status Bar


[REVIEW] ROI: 1024x600 FPS: 1000 EXP: 8X (0.125 ms) TrigPos: 50% -88%
[REVIEW] ROI: 1024x600 FPS: 1000 EXP: 8X (0.125 ms) TrigPos: 50% 88%
[REVIEW] ROI: 1024x600 FPS: 1000 EXP: 8X (0.125 ms) TrigPos: 50% A/C

7. Slide the battery door latch closed.
8. The TS3 should now power up. If it does not, please follow the instructions below for connectin the DC power supply and charging the battery.
9. Press the Menu button once to get the menus and status bar to appear on the LCD display.

Attaching the External DC Power Supply

The 12V DC Power Supply operates on 100-240VAC, 50-60Hz. The socket is a standard IEC 13, used worldwide for all types of electronic equipment. The power supply is shipped without power cord so that the user may use one appropriate for local power outlets.

1. Attach a power cord to the power supply and connect it to an AC power outlet.
2. Attach the power supply output cord to the camera via LEMO connectors. Note that the LEMO connector is keyed: the red dot on the connector will face the LCD side (back) of the camera.

Note: If the camera was powered down before connecting the power supply, it will now power up. While operating on battery power the Battery Status on the Status bar will show a negative number -88%. (See “Figure 2-2: Battery Charge Indicator on Status Bar”.) When connected to a power supply (with the battery installed) the number becomes positive. If no battery is present it changes to A/C>.

Charging the Battery

The TS3 battery does *not* charge automatically when the camera is attached to an external power supply while operating. Changing mode is initiated by pressing the ON/OFF button. When the battery is present while the camera is attached to an external power supply, the ON/OFF button will toggle the camera through three states: 1)normal operation; 2)charging (non operational); 3)O .

Note: Pressing the ON / OFF button toggles the camera between three Modes if both the battery and external power supply are present. It toggles the camera between two Modes: On /OFF if either the battery or the external supply is not present. (See “Table 2-3: ON / OFF Bu on” on page 10.)

Powering Down

If you press the ON/OFF button while the camera is operating, you will get see a message on the display asking if you wish to turn the camera off. If you click “OK” the camera will either power down or begin charging. If click “Cancel” or “MENU” the camera will return to its previous operating state. If you do nothing, the camera will wait approximately 60 seconds, then either begin charging or power down--it will not return to operating mode until it is powered up again.

Table 2-3: ON / OFF Button

Battery Present	External Supply	Mode	LEDs	Battery Charge % Indicator
X	X	1. Operating	Power / Camera / Battery (Green, Amber, or Red)	Batt: xx
X	X	2. Charging	Power / Battery (Green, Amber, or Red)	(LCD o)
X	X	3. O	None	(LCD o)
	X	1. Operating	Power / Camera / Battery (Blue)	A/C
	X	2. O	None	(LCD o)
X		1. Operating	Power / Camera / Battery (Green, Amber, or Red)	Batt: xx%
X		2. O		(LCD o)

The Battery LED changes color depending on the level of charge.

Table 2-4: Battery LED States

Operating / Charging	Charge Status	LED Behavior
Operating	>15%	Green
Charging	> 15%	Blinking Green
Operating	< 15% > 5%	Amber
Charging	<15% >5%	Blinking Amber
Operating	<5%	Blinking Red
Charging	<5%	Blinking Red
Operating	Not Installed	Blue

2-4 TS3 Memory and Mass Storage Options

The TS3 camera is equipped with 4GB or 8GB of internal high-speed internal memory. Images stored in this memory may be reviewed on the camera, external monitor via HDMI, or PC, then saved to any of four types of mass storage devices:

1. Solid State Hard drive (optional) in talled in the TS3 at the factory.
2. SD Cards (SDHC) inserted by the operator into the SDHC slot on the side of the TS3.
3. USB devices such as thumb drives or USB external hard drives connected via the USB port.
4. Memory devices on a networked PC using Fas*M*otion software (not Web Browser).

TS3 Solid State Hard Drives (Internal SSD)

Solid state hard drives (SSDs) are available as an option on the L and S series. (See “Table 1-1: TS3100-L and TS3100-S Models” on page 2.) These drives serve as mass storage devices for the camera and are installed in the camera at the factory. Image data from the TS3’s high-speed internal memory may be downloaded to the SSD, thus making room for the next high-speed image capture. While the SSD does not add to the recording time of the camera (the number of images it can record in one session), it does allow the user to download large quantities of image data without ever connecting the TS3 to a PC or other external device.

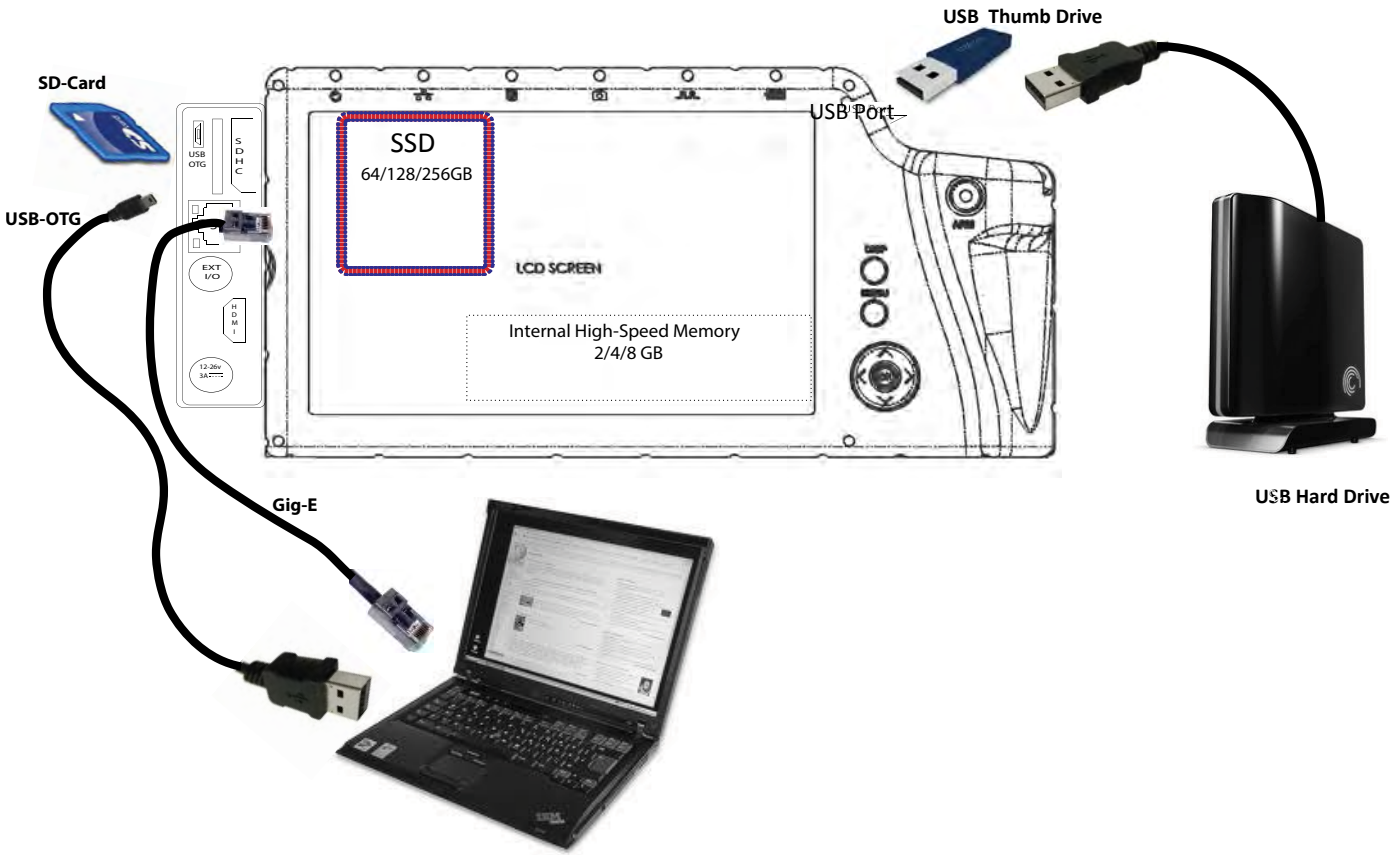
SD Card

The TS3 is shipped with a 16GB high performance SD Card. This card has two functions

- It can be used as a mass storage device for downloading and distributing images. SD Cards and card readers are very commonly used storage devices among PC users and photographers.
- Any field software updates for the TS3 from MIKROTRON will be installed via the SD Card.

Note: An SD Card when used for a software update must be reformatted before it can be reused as a mass storage device. See “Appendix H: TS3 Updates” on page 88.

Figure 2-3: Mass Storage



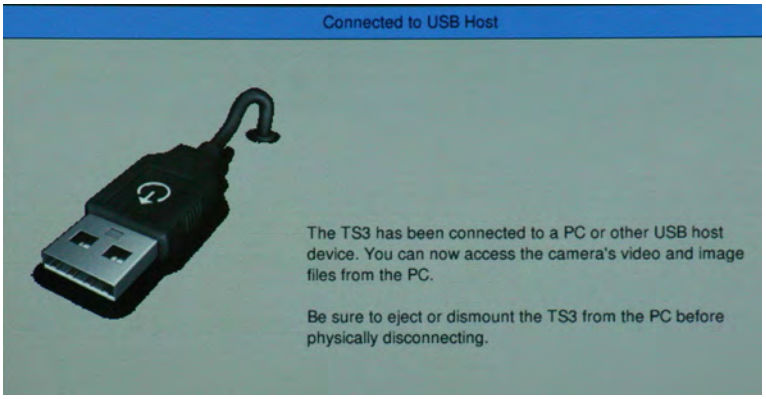
USB Port

The TS3 will act as a **Host** to any USB mass storage device connected at the USB port. (See “TS3 Top View” on page 4.) Image data may be saved to these devices.

USB-On The Go!

The USB-OTG port allows the camera to be connected as a slave to any PC using a USB-A to USB-Micro-B cable. Once connected via the TS3’s OTG port, any mass storage device on the camera can be accessed by the PC. This includes an SD Card, Solid State Drive, or thumb drive in the USB port. To use this option

Figure 2-4: USB-OTG on the TS3


Connected to USB Host
The TS3 has been connected to a PC or other USB host device. You can now access the camera's video and image files from the PC.
Be sure to eject or dismount the TS3 from the PC before physically disconnecting.

1. Power up the camera.
2. Install thumb drive and/or SD Card in the camera.
3. Attach the camera to the PC via the camera’s USB-OTG port, which is next to the SD Card slot on the side of the camera. (See ”TS3 Side View (Door open)” on page 5.) As each device is located by the PC an Autoplay window on the PC will open. This is a very simple way to transfer image data to a PC. This is for file access only --there is no way to control the camera via USB-OTG.

When you are finished, you need to eject the media from the PC. Click on the “Safely Remove Hardware and eject Media” icon on your computer’s task bar and select “Eject MIKROTRON Camera.”

Note: Any device that is connected to the camera *after* the camera and PC are connected will not be seen by the PC.

Table 2-5: TS3 Mass Storage Functionality

	Target Drive(s)	Function
TS3 Utilitie		
System/Storage/Explore	SSD/USB/SDHC	Move, Copy, Delete, review metadata of Image file
System/Storage/Format	SSD/USB/SDHC	Format drive
System/Storage/Eject	USB/SDHC	Safely Eject Media
Review/Save	SSD/USB/SDHC	Save image Data from Internal High-Speed Memory
Record Stil	SSD/USB/SDHC	Save a single still Image
Autosave	SSD/USB/SDHC	Autosave image Data from Internal High-Speed Memory
FasMotion Utilities		
Storage/Explore	PC Drives+SSD/USB/SDHC	Move, Copy, Delete, review metadata of Image file
Storage/Format	SSD/USB/SDHC	Format drive
Review/Save	PC Drives+SSD/USB/SDHC	Save image Data from Internal High-Speed Memory
Record Still	PC Drives+SSD/USB/SDHC	Save a single still Image
Autosave	PC Drives+SSD/USB/SDHC	Autosave image Data from Internal High-Speed Memory
PC via Gig-E Connection		
Explore	SSD/USB/SDHC	Open, Copy files, multiple files, directories From TS3 to PC only
Web Application	SSD/USB/SDHC	Open, Copy files (one at a time) from TS3 to PC only
Storage/Browse	SSD/USB/SDHC	Move, Copy, Delete (1 file at a time), review metadata of Image file
Storage/Format	SSD/USB/SDHC	Format drive
Review/Save	SSD/USB/SDHC	Save image Data from Internal High-Speed Memory
Record Still	PC Drives+SSD/USB/SDHC	Save a single still Image
Autosave	PC Drives+SSD/USB/SDHC	Autosave image Data from Internal High-Speed Memory
PC via USB-OTG:	SSD/USB/SDHC	Move, Copy and Delete all files and directories to and from TS3

3 TS3 Camera Setup

3-1 Camera Display and Menu Navigation Buttons

The **Display Button, Menu Button, and Directional Pad (D-Pad)** are found on the back of the camera to the right of the LCD. (See “TS3 Back View” on page 3.)

When the camera powers on for the first time, the default display is a live image with no menu displayed.

Pressing the **Display (DISP) Button** while toggles the LCD between four modes: 1) Display off; 2) Display on; and 3) Display on with Information bar; 4) Display on with Information bar and Histogram. When there is captured video to review, playback controls are added to modes 3 and 4.

The **Menu Button** toggles the on screen menus on and off . While navigating menus, the Menu button is used to go backward through levels of the menu. For example, if you are navigating a Menu pressing the Menu button will return you to the Menu Bar. (See Menu Terminology, below.)

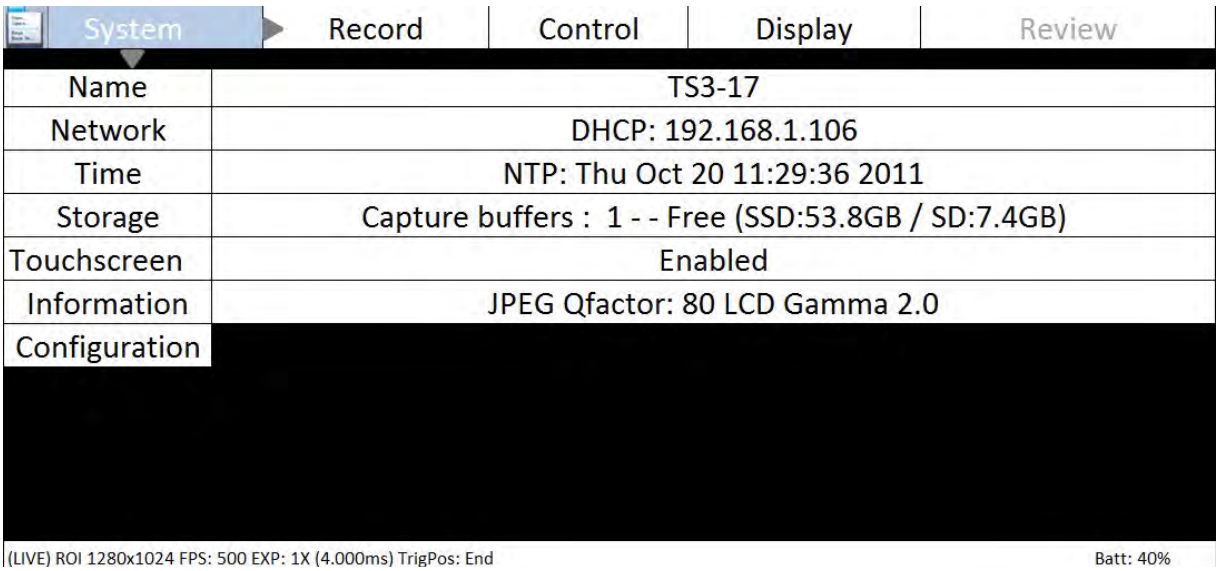
The **D-Pad** is used to move within menus and dialogs. It has an “OK” button in its center for selecting menu items and options

While navigating through menus, the current location is indicated by a change of color from white or green to gray. When navigating a Menu, the drop down selections will always appear in the left most column. The selected menu will appear in white letters in the Menu Bar. Selected or Enabled items turn green once the cursor is moved away from them.

Table 3-1: Menu Terminology

Menu Bar	Across the top of the display: Touch Menu Icon*, System, Record, Control, Display, Review
Menu	Having Made a selection from the Menu Bar, a drop down Menu Appears, such as the System Menu shown below. Present status for items in the selected menu are listed.
Element	The menu options i.e. Name, Network, etc. are called Menu Elements
Dialog Box	Having chosen an item from a menu, a dialog box may open such as the Frame Rate and Resolution. (See”Frame Rate and Resolution Menu” on page 23.) This is often a place where the user may make choices and/or input data.
Status Bar	The Status Bar is located at the bottom of the display. Information includes (from left to right): Operating Mode (Live= live view, CAP= recording, REVIEW= playback); ROI= Resolution; FPS= Frame rate; EXP= Exposure; Trigger Position; and ower /Battery Status (A/C= no battery, xx% = battery charge)

Figure 3-1: System Menu



3-2 Using the Touchscreen

The TS3 7” display uses touchscreen technology that allows the user to navigate through the menus and enter data with the touch of a finger rather than via the D-Pad.

A special icon in the upper left hand corner of the screen is present whenever Touch is enabled. Pressing this icon acts the same as pressing the MENU button: it toggles the menus on and off and allows you to navigate backwards through menus and dialogs.

Figure 3-2: Touchscreen Menu

Note: the TS3 touchscreen uses “resistive” technology that is sensitive to a light touch of a fingernail or stylus. Unlike “capacitive” technologies used in many smartphones and tablet PCs, it is not very sensitive to the flesh of a fingertip

To enable the Touchscreen:

1. Navigate to the System Menu, then to Touchscreen using the D-Pad.
2. If the touchscreen is currently disabled, there will be a “Disabled” button in the Touchscreen menu. If you click on that, it will turn green and the text will change to “Enabled.”

Whenever the Touchscreen is enabled there will be an icon in the upper left hand corner of the screen. Pressing on this acts the same as the MENU button.

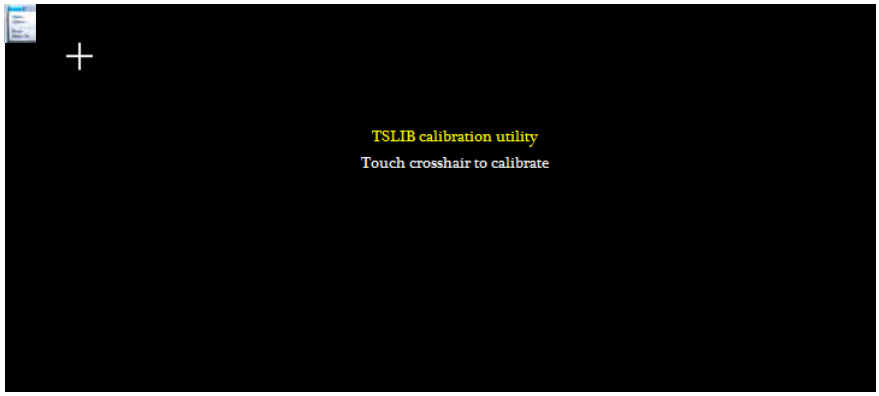
Calibration

The touchscreen is calibrated at the factory. Routine calibration of the touchscreen in not necessary. Calibration of the touch screen may be done if you feel that the screen is sensing your touches inaccurately. For example if you use the alpha-numeric keyboard and you are not always getting the intended character where you are touching it, you should re-calibrate the touchscreen.

To calibrate the Touchscreen:

Calibration of the touchscreen is very simple and only takes a few seconds.

Figure 3-3: Touchscreen Calibration



1. Navigate to the System Menu/ Touchscreen/Calibrate.
2. When you select “Calibrate” you will see a warning message: “Are you sure you want to re-calibrate the touchscreen?” Select “OK.” (This is there to prevent you from accidently calibrating th touchscreen while handling the camera.)
3. The Calibration screen, “Figure 3-3: Touchscreen Calibration", will appear and prompt you to touch a cross hair at each corner of the screen, then in the center. Be careful to touch the cross hairs accurately. It is best to use a stylus or other blunt plastic object

3-3 Controlling the Displays

Setting Defualt Gamma in User Preferences:

User Preferences is in the System/Configuration menu.

The Default Gamma setting is used both to set the defualt output Gamma for displayed and saved images, and to set the Gamma for the LCD display. Gamma of 1.0 (linear) is recommended unless you intend to encode your images with 2.2 Gamma.

LCD and HDMI setup in the Display Menu:

There are three menu elements in the Display menu that control the behavior of the displays. These are:

- LCD Adjust
- LCD Dimmer
- HDMI

The Image Adjust dialog opens when you click on the Edit button in the Image Adjust menu. The controls here adjust only the way images are displayed on the LCD. They do not change the images in camera memory or images that are or will be saved.

For any of the three controls here, LCD Brightness, LCD Contrast, and LCD Backlight, changes may be made either by clicking on the + and - boxes, which will change the associated item up or down in increments of 1, or you can click on the edit box itself to open a keypad. See “Figure 3-12: Keypad Dialog Boxes” on page 19.

LCD Brightness and Contrast have a range between -100 and 100 with a default value of 0. LCD Backlight has a range between 0 and 100 with a default value of 100.

Note: The Image Adjust, White Balance, and RGB Gain elements do *not* control the LCD display. These are part of the image processing pipeline that directly influence the saved image. (See “Image Pipeline” on page 32.)

The LCD Dimmer is a timer that turns the LCD display off after a number of minutes. There are four choices:

- O --the display will not “time out ”
- 1 Min. The display will go dark after 1 minutes of non-use.
- 5 Min. The display will go dark after 5 minutes of non-use.
- 10 Min. The display will go dark after 10 minutes of non-use.

Figure 3-4: LCD Display Controls

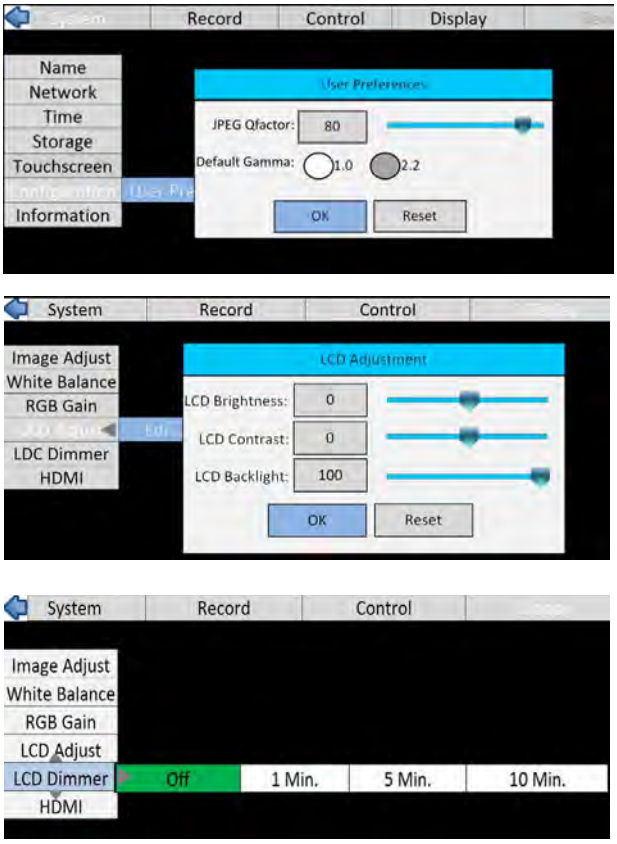


Figure 3-5: HDMI Controls

HDMI Display

While the 7” WVGA 800 x 480 display on the TS3 is perfectly adequate for setting image captures and even reviewing video, watching the same video on a large flat panel display makes sharing the imagery with others much easier. With the TS3 there is no need to download images to a PC to view them on a large display. Use a standard HDMI cable to connect the TS3 to an HDMI compatible display.

The **HDMI** output control is also accessed in the Display menu. The HDMI output can be Enabled and Disabled here and the resolution 640 x 480, 720p, or 1080p may be selected. (Any resolution not supported by a display attached to the TS3 will be Grayed out and the button not selectable.)

3-4 Connecting to a PC via Ethernet

The TS3 may be connected to a PC using the USB-OTG connection, (see "2-4 TS3 Memory and Mass Storage Options" on page 10) or via the Gig-E port. While the **USB-OTG** connection is extremely useful for file transfers, an Ethernet connection has two major advantages:

1. It can be used to control the camera via the built-in Web Application or InMotion Camera Control software.
2. The camera and PC need not to be physically close to each other as with the USB-OTG connection which is dependent on cables that are limited in length (generally less than 4.5m).

Benefits of TS3 Ethernet connectivity:

1. Once connected to a network, the TS3 may be accessed for file transfer and camera operation (including live views, recording, reviewing, etc.) by any PC on the network. Multiple cameras may be accessed and controlled on a network.
2. Using the camera's **Web Application** (built into the camera) any PC that has network access to a camera can control it without installing any software. This works with popular web browsers such as Google Chrome and Mozilla Firefox.

Setting up Networking on the Camera

The TS3's Networking settings may be configured manually or using DHCP. When shipped the cameras are set for DHCP. To change the setting

1. Navigate to the System Menu.
2. Select Network.
3. Choose between DHCP or Static. Choose DHCP in the camera will be placed on a network with a DHCP server running on it. Choose Static if the camera and any PCs used to access it are manually configurated.

Autoconfiguration

If the TS3 is configured for DHCP and it does not find a server, it will autoconfigure itself with an IP address 169.254.xx.xx.

Most PCs will do the same. So, most of the time, if the TS3 is configured for DHCP and you connect it to a PC that is also configured for DHCP, they will automatically connect without any further configuration

Figure 3-6: TS3 to PC Connections

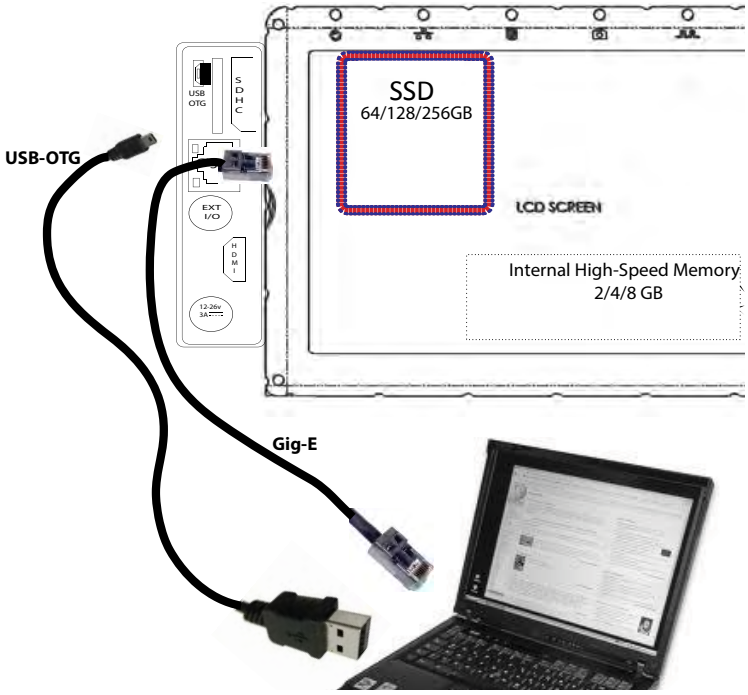


Figure 3-7: Network Menu

Table 3-2: Network LEDs

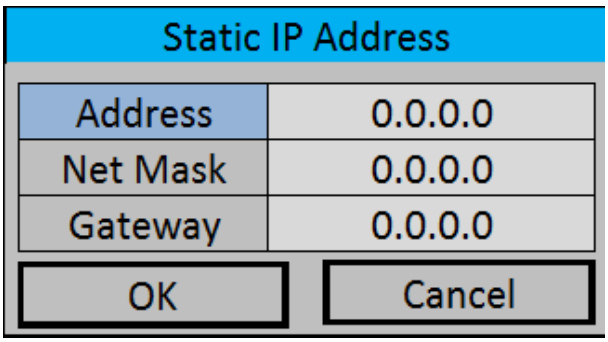
LEDs on RJ-45 Connector		Camera Networking LED
Green (Connection	Amber (activity	Amber (activity
1 Blink = 10Mb	Blinks for all network activit	Blinks for camera network activity onl
2 Blinks = 100Mb		
3 Blinks =1Gb		

If you choose to manually configure the network settings, there is a dialog box that opens to allow typing in the IP Address, Subnet Mask, and Gateway. (If Touchscreen is enabled, you will be able to use it with the alphanumeric keyboard for input of these values.)

If you are unsure of these settings, please consult your network administrator. If you need the MAC address of the camera, it is listed in System/Information/Status.

Note: the camera must be connected to an active network when configuring the IP address.

Figure 3-8: Static IP Dialog Box



3-5 Using the TS3 with a PC

To open the Networked TS3 in a Web browser to use the **TS3 Web App**:

1. Open a web browser on the PC. Of the available web browsers, Google Chrome has the best performance when using the Web App.
2. Type the camera's IP address or camera name into the browser's Location bar. For example, using the information from "Figure 3-9: Web Browser Screen", you would type 169.254.66.106 (IP address) or MIKROTRON_ts3 (the camera name) into the browser's Location bar.
3. A camera control application within the camera does the rest. A control menu will appear in your browser that will give a live camera view and complete control over the camera operation Details on use of the camera's web browser appear in Chapter 5 of this manual.

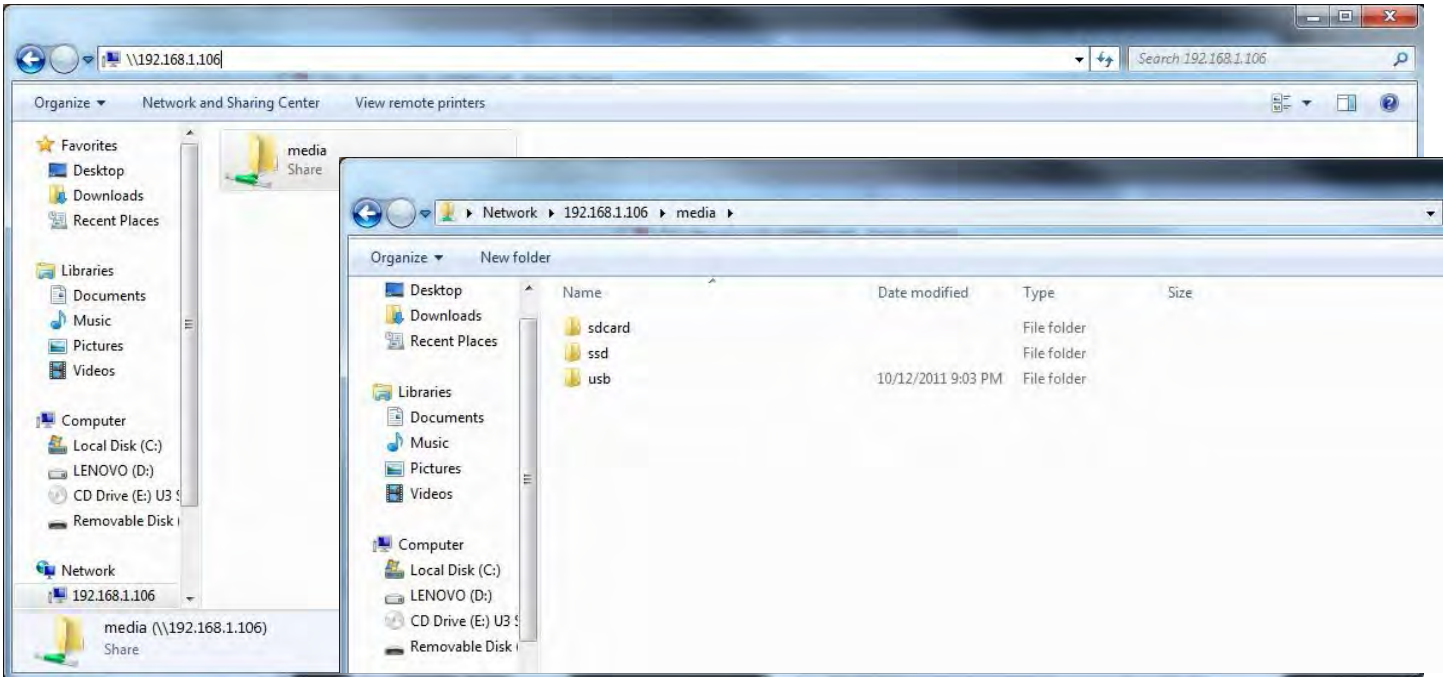
Figure 3-9: Web Browser Screen

To open the Networked TS3 in a Windows Explorer menu:

1. Open either a web browser or Windows Explorer.
2. Type the camera name or IP address in the Location bar, preceded by \\. So, using the same information as in the example above, type in either \\192.168.1.106, or \\mikrotron_ts3.

When the camera is viewed in Explorer, you will see the camera name or IP address under Network. Opening that, you will see a directory called “media,” which contains directories for each mass storage device installed on the camera. (See “Table 2-5: TS3 Mass Storage Functionality” on page 12.)

Figure 3-10: TS3 in Windows Explorer



3-6 TS3 Name the Camera

Camera Name

When the TS3 leaves the factory its default name is TS3-xxx. For example, looking at “Figure 3-11: Camera Name Menu” the camera used for the screen shot was TS3-17. The camera name can be used both for identification on a network and as part of the filename when saving images.

It may be beneficial to rename the camera according to its function, loyality, field of view, etc. depending on how the camera is to be deployed.

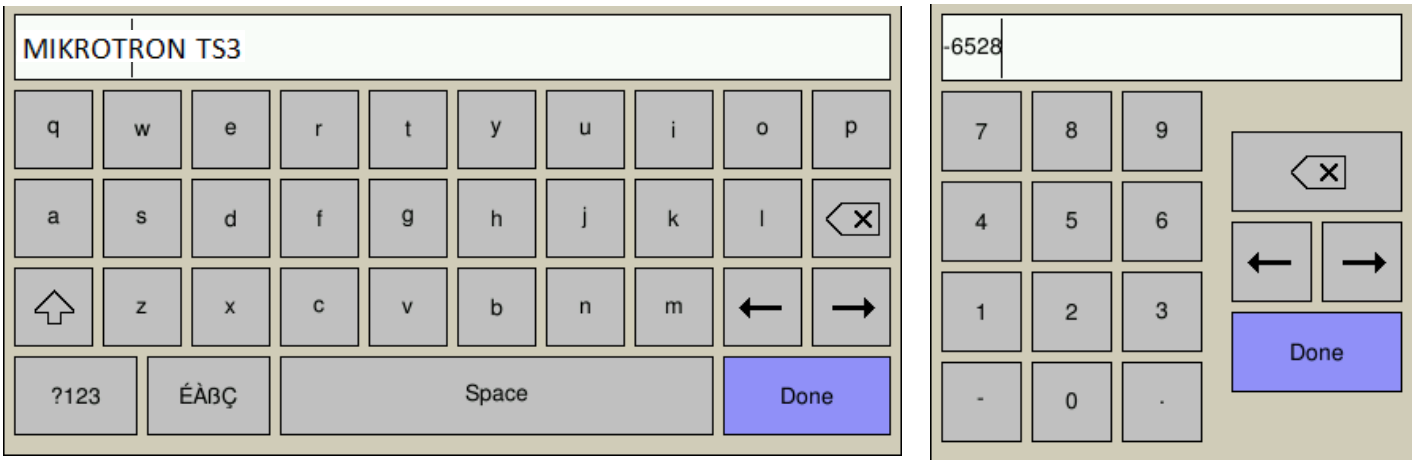
Figure 3-11: Camera Name Menu

To change the camera name:

1. Navigate to the System Menu.
2. Select “Name.”
3. Move the cursor to the box showing the current name and click “OK” to open the alpha-numeric dialog where you will enter the new camera name. If enabled, you can do this using the Touchscreen. If not you will use the D-Pad.
4. Delete the present camera name using the Backspace button in the dialog box, then enter the new name in its place.

Caution: There are many symbols available on the keypad that are not valid for camera naming. If you enter symbols that are not usable, those characters and any subsequent characters will be stripped from the camera name as soon as you navigate away from the Name Menu.

Figure 3-12: Keypad Dialog Boxes



3-7 Setting the Time

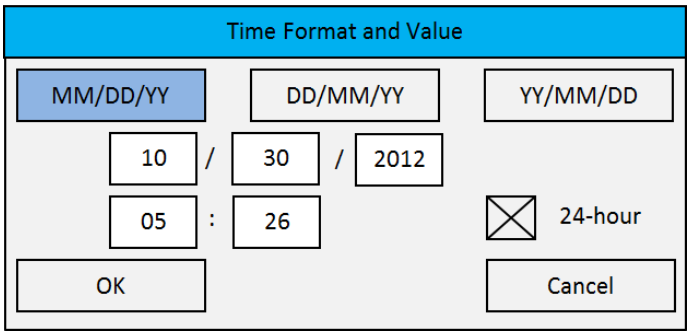
Time Setup on the TS3 is located in the System Menu. There are two choices for setting the time the camera: **User** and **NTP**.

If you select User, the time and date are manually entered into the camera. The camera's internal clock will maintain reasonable accuracy, but may drift over long periods of time. If NTP (Network Time Protocol) is used, the camera will get its time from an external NTP server via the Internet.

Setting the time Manually

1. Navigate to the System Menu and select Time.
2. Select the format you wish to use for the date and time: MM/DD/Y , DD/MM/YY, or YY/MM/DD.
3. Select 24-hour, if you wish to use a 24-hour display rather than a 12-hour.

Figure 3-13: Time Format Menu



Setting the Time via NTP

1. Connect the camera to a network with internet access. There is no need to attach the camera to a PC, although that is often the most obvious way to do it..
2. Navigate to the System Menu and select NTP.
3. Select an NTP server from the list. If there is a server that you would like to use that is not on the list, you may add it in the dialog box.
4. To exit the list, press the right arrow of the D-Pad and select OK. The TS3 will now connect to the NTP server and sync its clock. If the camera cannot connect with the server, it will pause operation for a couple of minutes while it re-tries. The camera will always poll the NTP server when it powers up if it has an Internet connection

Note: The TS3 will not poll the NTP server if the Internet connection is not made, either when the camera boots, or when exiting the NTP dialog. Between times when the camera polls the NTP server, it will maintain time with its internal clock.

5. Select "Zone" to set the camera to the local time zone.

3-8 Storage Setup

The Storage Menu gives the user some amount of access and control of the Camera memory and any external memory installed i.e. USB thumb drive or SD Card.

The TS3 has 2GB, 4GB, or 8GB (depending on model and option) of internal high-speed memory used for capturing high-speed imagery. All of this memory may be used to capture one high-speed event, or it may be partitioned to capture multiple events. Total record time will depend on resolution, frame rate, and bit depth.

Configure **Session**:

Session selects the amount of memory to be used for capturing imagery, which dictates the number of frames captured as well as the capture time

1. Navigate to the System Menu.
2. Select Session
3. Use the touch-enabled slider to select the amount of memory for the session (in incrments of 256MB). Note that the number of frames and session time will change.
4. When the slider is selected, the D-Pad may also be used. This is a good way to get the exact value you wish to use.

Explore allows you to access the SSD (Solid State Drive installed internally to the TS3), the SD Card inserted into the slot on the side of the camera, or a USB thumb drive connected via the USB port for file t ansfer:

1. Navigate to the System Menu.
2. Select Storage.
3. Select Explore
4. A selection menu will open allowing you to pick the storage device you wish to access: SSD, SDCard, or USB. Once you select the storage device, you will see the directory choices: Stills (containing stills taken by the camera), Stacks (stacks of high-speed video saved as TIFF, BMP, JPEG files), and Video (AVI files)
5. Open the Stills, Stacks, or Videos folder by double-clicking on your choice. This will open the dialog shown in Figure 3-16, displaying the list captured imagery and a thumbnail and brief description of the currently selected item.

Note: This list acts like a “spinner” when touch is enabled. Swiping the list up or down will make it spin, allowing you to move through the list quickly.

Figure 3-14: Storage Menu

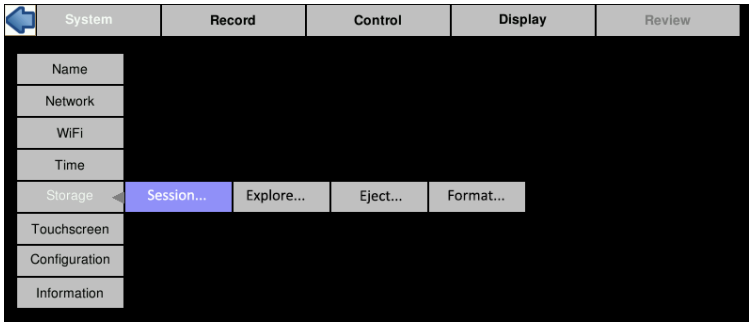


Figure 3-15: Session

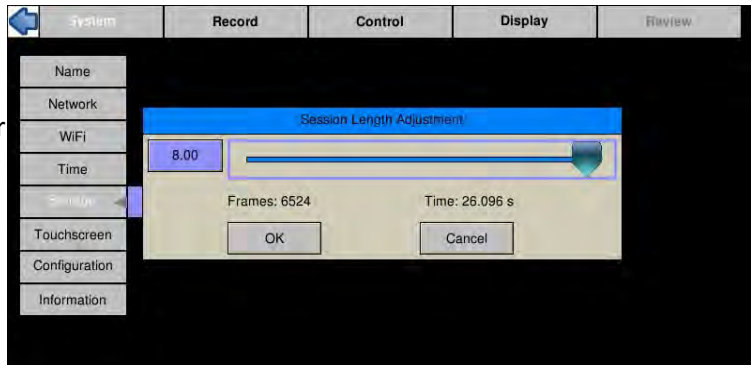
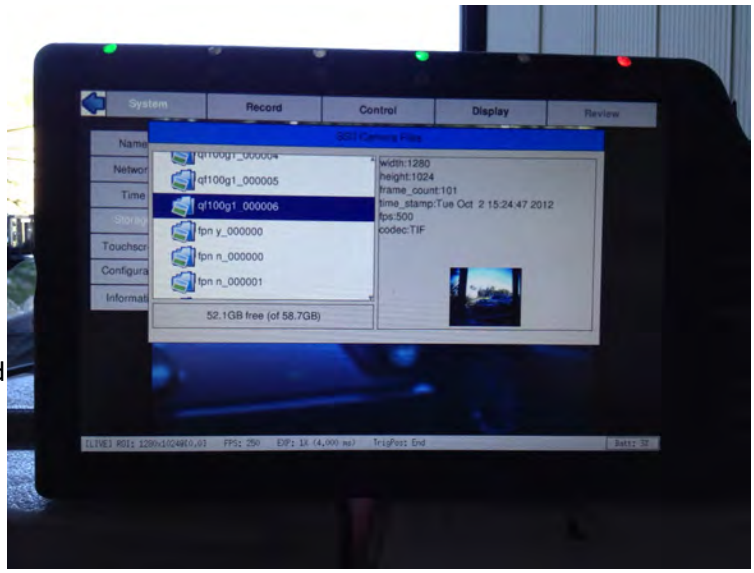


Figure 3-16: System Explore Dialog: File Stacks



6. Double click on any item and a File Action dialog will open that will allow you to Copy or Move the item to another storage device on the system, or delete it.
7. When done, use the Menu or Back button to navigate away.

Figure 3-17: File Action Dialog

Eject, also on the **Storage Menu**, should be used whenever you wish to remove media from the TS3.

NOTE: Failure to eject SDCards or USB devices before removal may result in incomplete transfers.

The **Format** function on the Storage Menu should be used with some caution as formatting any media will remove any data on it.

3-9 Configuration and Camera Information

TS3 Configurations, which include all Network, Time, and all camera settings can be Saved, Reloaded, or Reset to factory defaults.

1. From the System Menu, navigate to Configuration
2. Select **Save** to save the current configuration. The configuration may be saved as Configuration # or Configuration #2
3. Select **Load** to load a saved Configuration (Configuration #1, or #2
4. Select Reset to load the factory default configuration

General information about the camera, including MAC address and versions of software, FPGA, Sensor and Gig-E are available in Information in the system Menu.

3-10 Reset

There are two levels of Reset available on the TS3, '**Soft Reset**,' and '**Hard Reset**.'

The '**Soft Reset**' is similar to a PC reset or warm boot. It does not change any settings or power the system down, it simply restarts the user interface and clears out any error conditions. All user configurations and all image data are preserved.

The '**Hard Reset**' resets the camera configuration back of its factory settings. This eliminates the current user settings as ell as any saved configurations (Co fig 1 and Co fig 2) and erases any image data in the camera. For these reasons, the Hard Reset is very seldom done. There may be instances when you will directed to do a Hard Reset a er performing an update or maintenance task, but it is not done routinel .

4 Recording with the TS3

4-1 Setting Frame Rate and Resolution

Frame rate and resolution are set together as they are interactive. The maximum frame rate of the camera is based on its resolution as seen in “Table 4-1: Frame Rates and Resolutions , below.

Table 4-1: Frame Rates and Resolutions

Frame Rates	60	125	250	500	1000	1250	2000	4000	5600
Resolutions									
1280 x 1024	X	X	X	X					
1024 x 1024	X	X	X	X					
1280 x 720	X	X	X	X					
1024 x 600	X	X	X	X	X				
800 x 600	X	X	X	X	X	X			
800 x 480	X	X	X	X	X	X			
640 x 480	X	X	X	X	X	X			
1280 x 256	X	X	X	X	X	X	X		
512 x 512	X	X	X	X	X	X	X		
320 x 240	X	X	X	X	X	X	X	X	X
320 x 200	X	X	X	X	X	X	X	X	X
200 x 200	X	X	X	X	X	X	X	X	X

Scale and Resolution/Frame Rate

Selecting the proper resolution and frame rate for a given high-speed event is important. It is based on the Field of View (FOV) required to get a good image of your object of interest and the speed at which the object will move through that FOV.

For example, if you wish to image an automobile travelling at 50 mph across an intersection, full resolution and a relatively slow frame rate will work because your field of view (FOV) will be large and the car will not be moving through it very quickly.

Imaging a bird travelling at the same speed will require a much smaller FOV as the bird is 1/20th the size of the car. If you wish to use the same scale (object size/FOV), the FOV becomes 1/20th the size and the bird moves through it 20x as fast.

If you got acceptable imaging of an auto at 60FPS, it may take 1250FPS to get similarly acceptable imaging of a bird at moving the same speed.

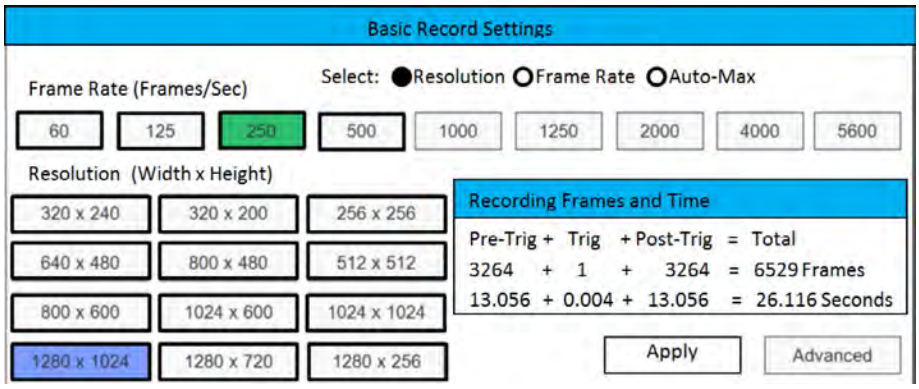
Aliasing and Frame Rate

If you are imaging a motion that is cyclical in nature like a wheel spinning or a lever moving up and down, it is important to use a high enough frame rate to avoid motion aliasing. If you know the speed of the object, use a frame rate at least a few times as fast as the repetition rate to get a valid characterization of the motion. If you don’t know the speed, use as high a frame rate as possible to start with and adjust from there. (Be sure to analyze the movement one frame at a time as the playback speed may cause aliasing as well.)

Generally you will choose to use the largest resolution possible for the frame rate required. This will give you the best definition of your object of interest. Smaller resolutions may be desired in order to increase the record time.

Note: The display resolution of the TS3 LCD is 800 x 480. To set the **Frame Rate and Resolut on** of the TS3:

Figure 4-1: Frame Rate and Resolution Menu

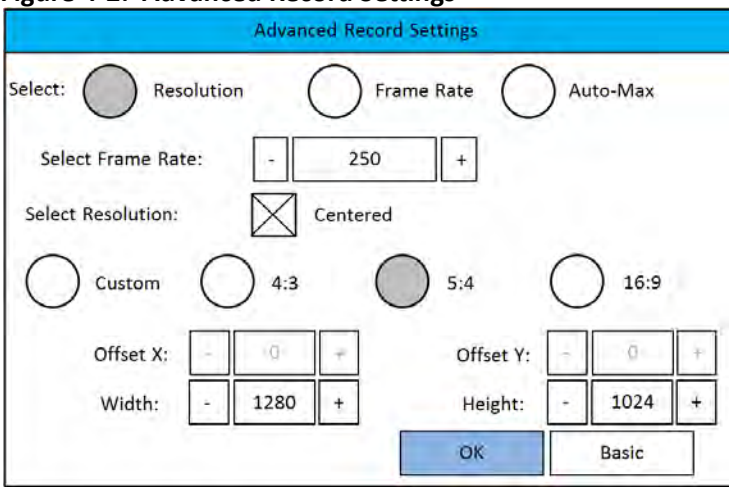


1. Navigate to the Record Menu / Settings and select either the Resolution or Frame Rate button to open the Record Settings Menus. (Either the Basic or Advanced menu will open, depending on the last one you used.)
2. In the Basic Record Setting Menu, Select Resolution or Frame Rate, or Auto-Max:

- If you select Resolution, you may pick from any resolution--only the valid frame rates for that choice will be available.
- If you select Frame Rate, you may pick from any frame rate--only valid resolutions for that choice will be available.
- If you select Auto-Max, you may pick any frame rate or resolution. The system will then select the maximum corresponding resolution or frame rate for your choice.

3. Click on the Apply button when you are satisfied with our choices. The camera will automatically adjust the shutter speed to match the frame rate selected. The live display will now reflect the changes made and give you and opportunity to accept or cancel them.

Figure 4-2: Advanced Record Settings



Controls in the Advanced Record Settings dialog settings work the same as in the “Basic” menu, except that edit boxes and spinners replace the presets, offering a much wider range and greater precision.

Resolutions can be refined to any even-numbered pair from 24 x 12 to 1280 x 1024.

Frame rates may be refined to any number from 24 to 98437 fps.

Choose from the four aspect ratio choices: Custom, 4:3, 5:4, 16:9.

Offset Control:

Most of the time, you make use of the best resolving properties of your lens, you will want to center the image at the optical center, which corresponds to the center of the sensor. In this case you would make sure that the “Center” check box is checked.

It is also possible, that you will wish to shift your ROI (Region of Interest) without moving the camera.

Lets say, for example, that you have captured images at 1024 x 1024 @ 500fps and are now interested at capturing a 512 x 512 portion of the scene, lets say the bottom right hand quarter @ 2000fps.

In this case, you would wish to add 512 to both the X and Y offset. For a 1024 x 1024 centered image the offsets will be 128 and 0. The resultant offsets for a 512 x 512 image (lower right quadrant) would be 740 and 512.

4-2 Setting Shutter Speed

Choosing the right shutter speed is dependent not only on the speed at which an object is travelling through the FOV, it is also dependent on how the imagery is going to be used.

For motion analysis it is best to get as short an exposure as possible in order to limit motion blur. (Motion blur an be defined as the number of pixels traversed by an edge of an object during an exposure.)

For smooth video, on the other hand, long exposures are best. These make for more attractive movies, but blurry stills

In the TS3, exposure times are expressed as 1X, 2X, 4X, 8X, and MAX. These are defined as

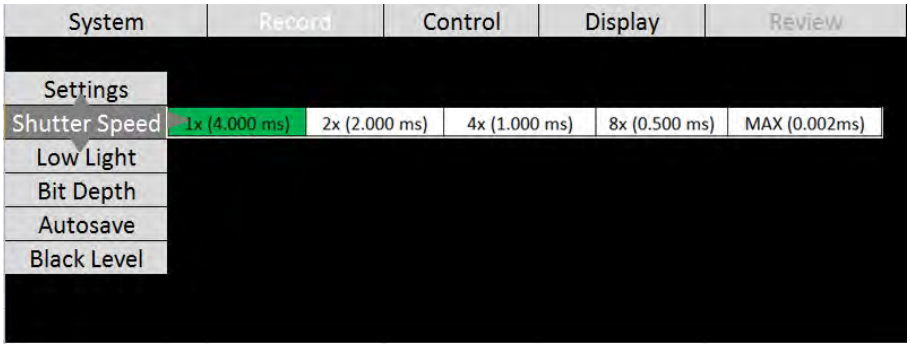
$$1/(\text{Frame rate} * n\text{X})$$

For 500FPS for example: 1/(500FPS * 1X)= 2ms; 1/(500FPS * 2X) = 1ms; 1/(500FPS * 4X) = 0.5ms, etc. MAX (shortest) exposure time is .002ms (2 µs).

Table 4-2: Frame Rates and Shutter Speeds

Frame Rates / Shutter Speeds	60 FPS	125 FPS	250 FPS	500 FPS	1000 FPS	1250 FPS	2000 FPS	4000 FPS	5600 FPS
1X	16.667ms	8.0ms	4.0ms	2.0ms	1.0ms	800µs	500µs	250µs	179µs
1X	1/60 s	1/125 s	1/250 s	1/500 s	1/1000 s	1/1250 s	1/2000 s	1/4000 s	1/5600 s
2X	8.333ms	4.0ms	2.0ms	1.0ms	500µs	400µs	250µs	125µs	89µs
2X	1/120 s	1/250 s	1/500 s	1/1000 s	1/2000 s	1/2500 s	1/4000 s	1/8000 s	1/11200 s
4X	4.167ms	2.0ms	1.0ms	500µs	250µs	200µs	125µs	62µs	45µs
4X	1/240 s	1/500 s	1/1000 s	1/2000 s	1/4000 s	1/5000 s	1/8000 s	1/16000 s	1/22400 s
8X	2.083ms	1.0ms	500µs	250µs	125µs	.10ms	62µs	31µs	22µs
8X	1/480 s	1/1000 s	1/2000 s	1/4000 s	1/8000 s	1/10000 s	1/16000 s	1/32000 s	1/44800 s
MAX	2µs	2µs	2µs	2µs	2µs	2µs	2µs	2µs	2µs

Figure 4-3: Shutter Speed Menu



Setting the Shutter Speed:

1. Navigate to Record Menu.
2. Select Shutter Speed.
3. Select 1X, 2X, 4X, 8X, or MAX. Press the Menu Button a few times until the Menus are cleared from the LCD screen.

Assuming you have installed a lens (See “2-2 Installing the Lens” on page 7), you should now see a live image. You may need to adjust the lens F-stop or the lighting. Press the Display Button once to view a histogram to confirm that the image you see is not clipped (too dark or over-saturated.)

Note: The camera is capable of setting shutter speeds in increments of one microsecond, but not from the on-camera menus. For finer control of shutter speed, use the Web-Application. (See “6-4 Record Settings” on p e 45.)

4-3 Low Light Mode

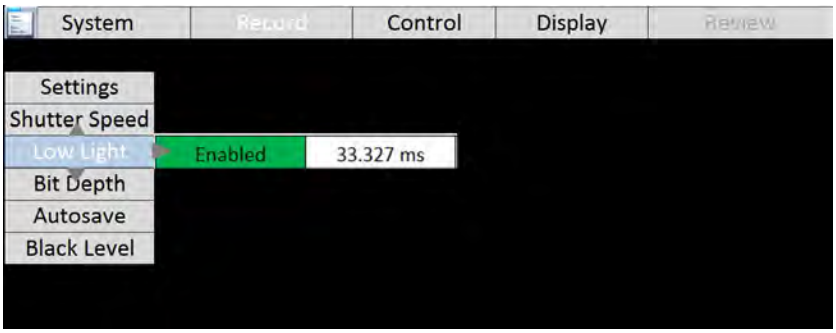
There is an option labeled “Low Light.” **THIS IS NOT A SHUTTER SPEED USED FOR RECORDING!** This is a special shutter speed that works in “Live Mode” only--for Live view and *not* while recording.

In some special circumstances, the light available for setting up the TS3 for a high-speed event is not the same as what will be used for event itself. For example, you may be using and extremely bright light or light of a spectrum that would be harmful or uncomfortable for people to work under. In Low Light Mode the camera framing and focusing can be done in available light.

The exposure for Low Light Mode is much longer than would be possible for a high frame rate. The default shutter speed for Low Light mode is 33.327ms, which is the “1X” shutter speed for 30 FPS. The shutter speed for Low Light may be adjusted via the Web-App or custom camera software, but not via the on-camera interface.

To enter Low Light Mode:

Figure 4-4: Low Light Menu



Note: Be careful when using the Low Light feature! **It is very easy to forget that it is on!** Remember to set your exposure for the light that will be present during the image capture.

1. Set the Shutter Speed just as you need it for the high speed event (as described in “4-2 Setting Shutter Speed”).
2. Navigate to the Record/Low Light Menu.
3. If Low Light is not enabled, there will be two items in the menu: “Disabled,” and an exposure setting (33.327 ms by default). When you click on the “Disabled” button, it will turn green and change to “Enabled.” You will notice immediately that the Live image is much brighter.
4. Press the Arm Button.

The camera will begin recording. You will notice that the image is darker now than in Live Mode.

5. Press Arm again to quit recording. (Click “OK” on the Warning message to Cancel.)

4-4 Setting Bit Depth

To choose the recording bit depth:

1. Navigate to the Record Menu.
2. Select Bit Depth.
3. Select 8-low, 8-mid, 8-high, or 10-bit. If any of the 8-bit mappings are chosen, the live image will immediately reflect that change. If 10-bit is chosen, the displayed live image will default to 8-high.

If Bit Depth is set to 10 in the Record Menu, a bit depth selection will appear in the The Display Menu. The choices here are 8-low, 8-mid, and 8-high. This selects the 8-bits used for the display and for saving to media.

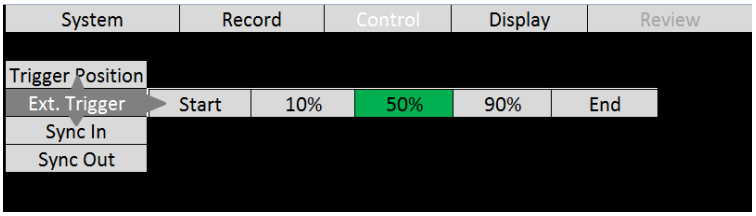
4-5 Configuring the Trigger

To Set the **Trigger Position** in the TS3:

1. Navigate to the Control Menu.
2. Select **Trigger Position**.
3. Select Start, 10%, 50%, 90% or End.

Note: When controlling the camera via Web-Application or Fas*M*otion so are, it is possible to position the trigger in 1% or even 1-frame increments.

Figure 4-5: Trigger Position

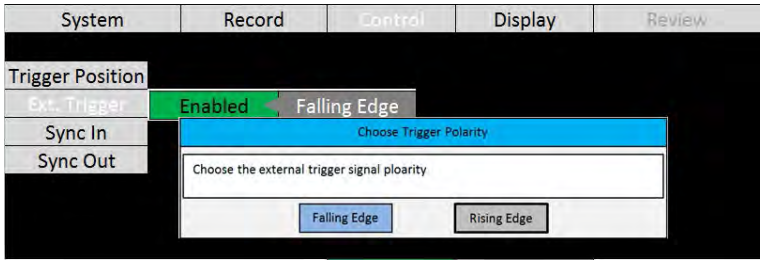


Enabling the External Trigger

There are times when manually pressing the trigger button is not practical. The camera may be mounted in a location that is difficult or dangerous to reach, or it may be that the precision required to activate the trigger is much easier to maintain through electrical means.

1. Navigate to the Control Menu.
2. Select Ext. Trigger.
3. If Disabled, click on the “Disabled” button. It will turn green and the text will change to “Enabled.”
4. The next button to the right will either say Rising or Falling Edge. If you need to change the setting , click on this button to open the dialog box pictured in “Figure 4-6: External Trigger”.

Figure 4-6: External Trigger



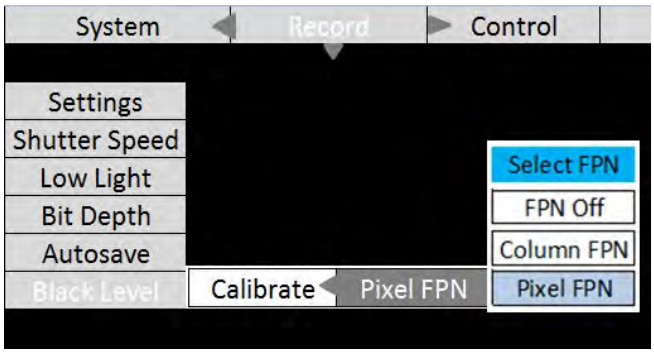
Please refer to “Appendix D: Power and I/O Connections” on page 82 for connection information and warnings.

4-6 Black Level Calibration

Black level calibration does two things:

1. It sets the black level of the camera to ensure that, in the absence of all light, there is no offset or clipping (the “blackest” pixel will have a value of 0).
2. Dark frame data is saved for correcting Fixed Pattern Noise (FPN).

Figure 4-7: Black Level Calibration and Settings



NOTE: Fixed Pattern Noise exists on every image sensor.

Calibrate Black Level:

The general rule is to do a Black Level Calibration if ever you believe the image looks noisy with Pixel FPN turned on. To be assured that you are getting the best possible images, perform a calibration:

- When you first boot the camera up.
- If you change Shutter Speed, Frame Rate, Resolution, or Offset.

To Calibrate the Camera

1. Navigate to Record/Black Level
2. Shut out all light to the sensor: close the f-stop down all the way and put a lens cap on it or cover it securely.
3. Click on “Calibrate.” There is a prompt to confirm that you have the lens cap on. You will see a little progress bar and you will see a couple of noisy images on the screen. When done, if Pixel FPN is on, the live image with the lens cap in place should be black.
4. Next to the Calibrate button, you will see an FPN selection bu on that will say FPN Off , Column FPN, or Pixel FPN. Click on that button and select the FPN setting you wish to use, based on the following:

Pixel FPN is a per-pixel image correction th a is done in the TS3’s image processor engine. It provides the cleanest images available. This is the setting that is most highly recommended, especially if the images will be downloaded or viewed on large, high-contrast displays.

Column FPN is an image correction done on the TS3’s sensor. It does not do as good a job cleaning up the images as Pixel FPN.

FPN Off means that there is no noise correction being used.

4-7 Record: Arm and Trigger

Lights Camera Action!

- Black Level Calibration has been don
- The scene is framed and focused
- The Resolution and Frame rate are set
- The Shutter Speed is set
- The Bit Depth is set
- The Trigger Point and Trigger Type is set

Take a Still JPEG

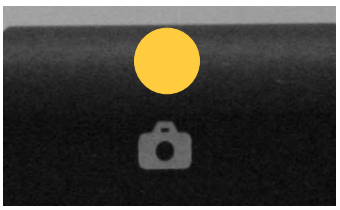
Still JPEG Image. It is optional, but ercommended, to take a reference still of the scene:

1. With the TS3 in Live Mode (not Recording or Reviewing a recording) press the Trigger Button.
2. A dialog box will appear asking where to store the image. Select the storage media you wish to use. (The image will be saved in <storage device>/dcim/100fastc.)

To begin Recording, Press the **Arm Button**.

When the Arm Button is pressed the camera begins recording into its circular buffer. The Camera LED will change from Green (LIve) to slowly flashing Amber. It will record for an indefinite period of time until it sets a Trigger. (See ”4-5 Configuring the Trigger” on page 26.)

Figure 4-8: Camera LED



If the Arm Button is pressed a second time, the Recording will abort. A courtesy message will appear asking for confirmation. You will need to use the OK Button on the D-Pad to accept.

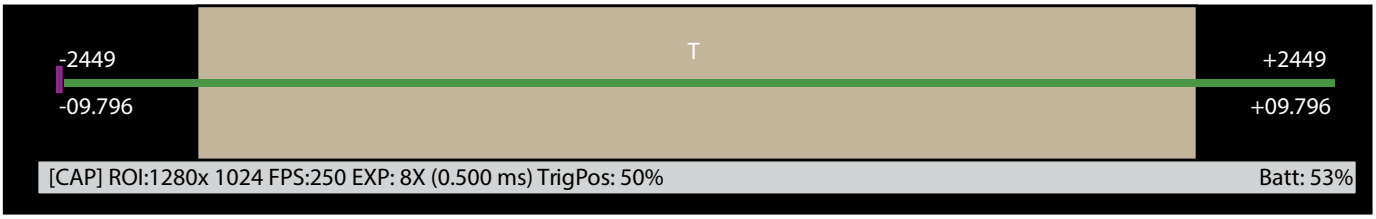
The recording state is indicated by a progress bar at the bottom of the TS3 LCD display. (See “Figure 4-9: Progress: Armed TS3”.) For this example, a 50% Trigger Point has been selected. The yellow/green bar represents the record buffer. The yellow half represents the pre-trigger portion the green represents the post-trigger portion. The “T” in the center of the bar represents the Trigger Point (frame “0”).

The numbers above and below the bar on each side indicate the number of frames and seconds for the pre-trigger portion to the left, and the post-trigger portion to the right. In this instance, because the Trigger Point is set at 50%, both the number of frames and amount of time is the same on both ends.

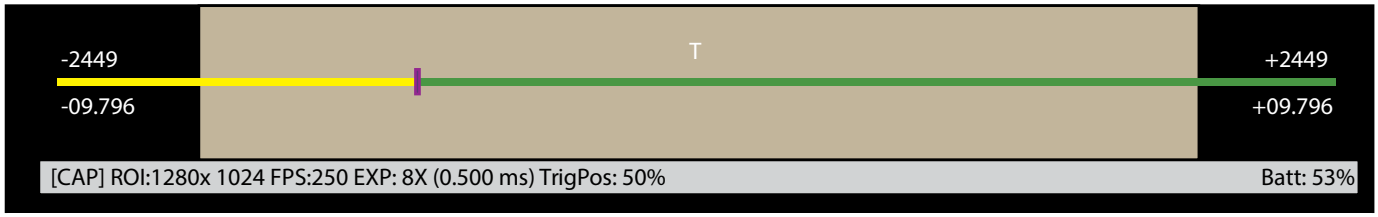
Note: If the TS3 is triggered before the pre-trigger portion of the buffer is full, it will immediately cease taking pre-trigger frames, record frame “0” and progress to the post-trigger portion of th recording. When complete, the recording will have contiguous frames, with the full complement of post -trigger frames, but fewer pre-trigger frames. (See “4-5 Configuring the Trigger” on page 26.)

Figure 4-9: Progress: Armed TS3

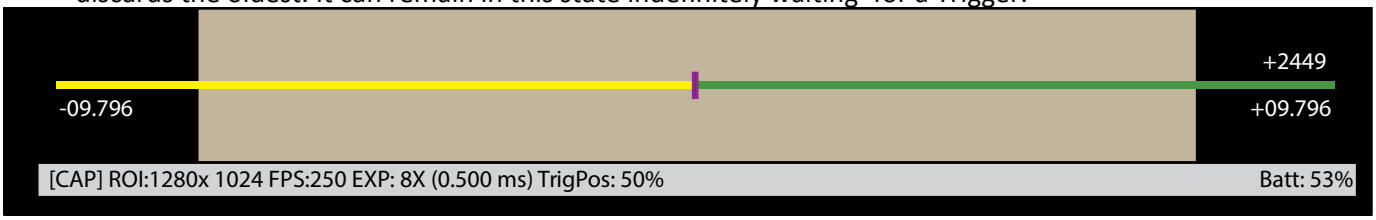
The recording has just been started (the Arm Button has just been pushed). The green progress line spans the whole distance between the left edge and the trigger point.



The recording has progressed through a little more than half of the pre-trigger portion. The marker has moved and the yellow line has proceeded with the progress of the recording.



All of the pre-trigger frames have been recorded. The TS3 is continuing to record new frames as it discards the oldest. It can remain in this state indefinitely waiting for a Trigger.

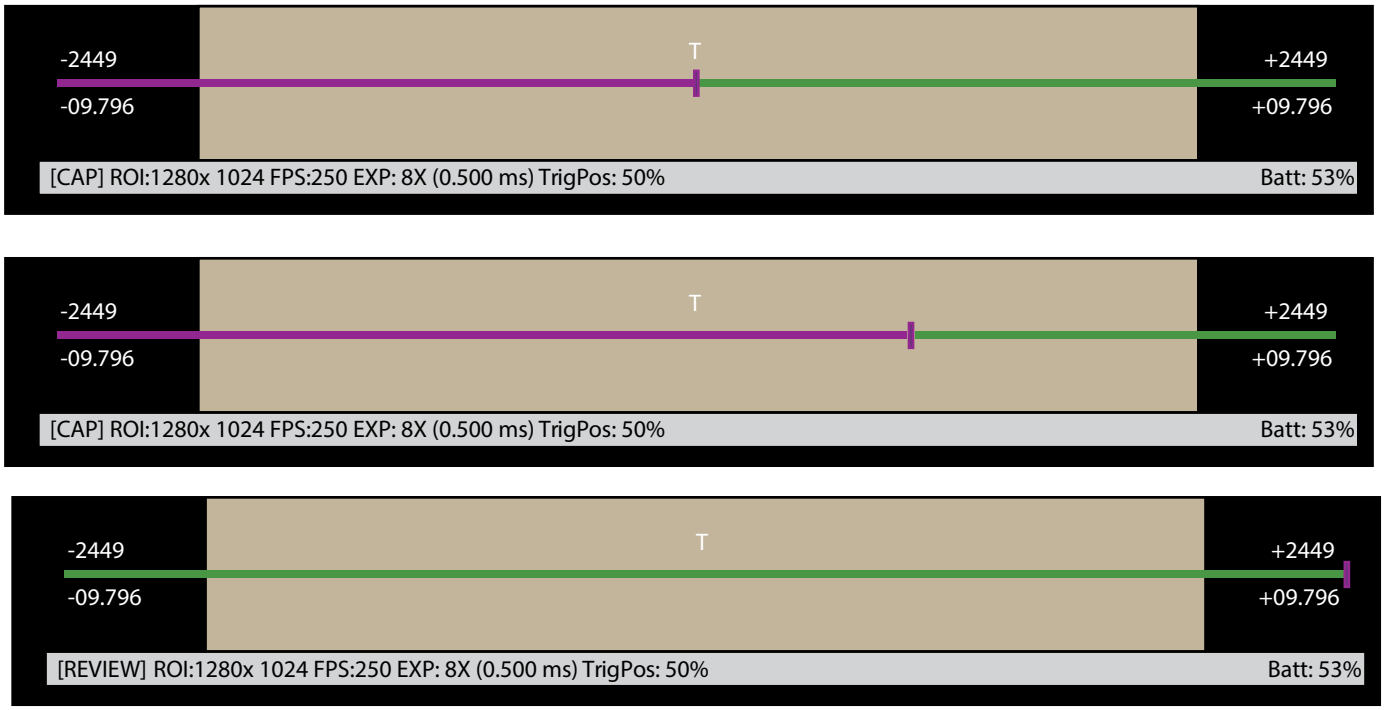


Trigger

Press the Trigger button, (see “TS3 Top View” on page 4) or send an electrical trigger signal (see “Appendix D: Power and I/O Connections).

When triggered, the TS3 will capture frame “0” and the post-trigger frames. The progress bar will change color and move from the trigger point to the end as in the three images below. When the recording is complete, the progress bar will turn solid green.

Figure 4-10: Recording Progress: Triggered TS3



The TS3 will now either enter Review Mode or, if **Autosave** has been enabled, the camera will save the images to a mass storage device and go back to Armed Mode, capturing pre-trigger frames and watching for a Trigger.

4-8 Autosave

The TS3 may be used to capture many consecutive events. Using Autosave, this can be done unattended, that is, the camera may be left at a location to automatically, Trigger, Save captured imagery, and then re-Arm itself indefinitely-constrained only by the mass storage space available.

Consider that a TS3 with an optional 256GB SSD installed, depending on the resolution and download file format, could record and save hundreds or even thousands of events in a completely unattended mode! Even if using an SDHC, many events may be captured.

Advantages of using Autosave:

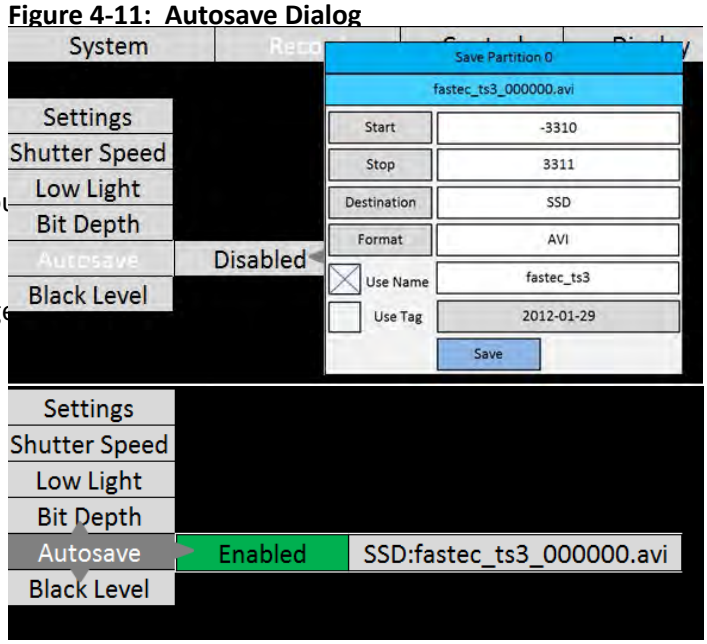
- Autosave is the only choice for **multiple unattended events**. For remote locations or location where networking is not possible, or for long shifts where there may be multiple events of interest that need to be captured without human intervention.
- Autosave is also useful for **production environments** or in any scenario where it is used for multiple consecutive tests without any setup changes. Here it is preferred because it limits human intervention, thereby limiting both human effort and the possibility of human error.
- In an **unattended event,** especially in a **remote location** or when there is no easy access to the camera, Autosave is recommended because it is the quickest way to secure the image data. Saving the data to nonvolatile memory can be important if there is a possibility of power loss.

- Use Autosave for any unattended event where there is a possibility of a spurious trigger. If this happens to an unattended camera, it is possible that the camera will trigger prematurely. If Autosave is used, there is a good chance that the camera will have returned back to Record mode in time to capture the planned event.

To set up **Autosave**:

1. Navigate to the **Record Menu**
2. Select Autosave.
3. Select Disabled. A dialog box will open to allow you to set up Start/Stop frames for downloading (the Start/Stop times for the recording are the defaults), the destination drive (mass storage target for downloads), file type options, and options for naming the downloaded files. (See "4- 12 Saving Images to Mass Storage" on page 35.)
4. When finished setting up the Autosave setting click on the Save button. When you navigate back to the System menu the "Disabled" button will have turned green and say "Enabled." The next button over will reflect the target file name

Figure 4-11: Autosave Dialog



Note: Autosave will continue re-arming itself, capturing images and downloading them until the target drive runs out of space. At this time it will progress to Review mode so the user download manually to a different drive or clear space.

4-9 Reviewing Captured Imagery: Playback

Once the recording is complete, if Autosave is not enabled, the TS3 will open the recording in Review Mode. There are three things to do in Review:

1. **Play** the video--play it forward, backward, frame by frame, adjust the cut-in and cut-out points (find the interesting portion of the clip), etc.
2. **Adjust** the image brightness, contrast, gamma, bit depth, color, etc. (See "4-10 Image Processing" on page 32.)
3. **Save** video to a mass storage device. (See "4-12 Saving Images to Mass Storage" on page 35.)

To Review the video:

In Review Mode there is a series of buttons on the bottom of the display, and a progress bar, very much like the one used for Record Mode to mark the place in the video currently being viewed.

Figure 4-12: Playback Buttons

To enter Review / Play:

1. Either complete a recording, which will automatically open Review / Play, or navigate to the Review Menu and select Play. This will only be available when there is a recording in the TS3 image buffer and the camera is not Recording or Saving to storage. When the image buffer is empty the Review Menu text will be grayed and the menu items are not accessible.
2. Use the Playback Buttons or touch-enabled slider to move through the imagery. The Status Bar will reflect the record frame rate (FPS), the playback speed, current frame number, frame time (relative to the trigger), and the Cut-In and Cut-Out points.

Table 4-3: Playback Control

The playback buttons may be used with the touchscreen, if enabled (see "3-2 Using the Touchscreen" on page 14) or the D-Pad.

	Returns to Live image. (Recorded image is still in buffer.) To return to Play, navigate to Review Menu and select Play.
	Creates new Cut-In point at current frame. To remove Cut-In point, click again, then move cursor.
	Go to beginning of clip--goes to Cut-In point. Click a second time and it goes to the very beginning of the video.
	Move one frame backward. When highlighted, hold OK button on D-Pad to skip backward.
	Play backward. Use up and down buttons on D-Pad to adjust speed.
	Pause play.
	Play forward. Use up and down buttons on D-Pad to adjust speed.
	Move one frame forward. When highlighted, hold OK button on D-Pad to skip forward.
	Move to end of clip--goes to Cut-Out point. Click a second time to go to the end of the video.
	Creates new Cut-Out point at current frame. To remove Cut-Out point, click again, then move cursor.
	Jump to Trigger frame.
	Open Save Partition dialog box to save clip. (Uses current Cut-In/Out points for Start and Stop frames.

Table 4-4: Playback Rates

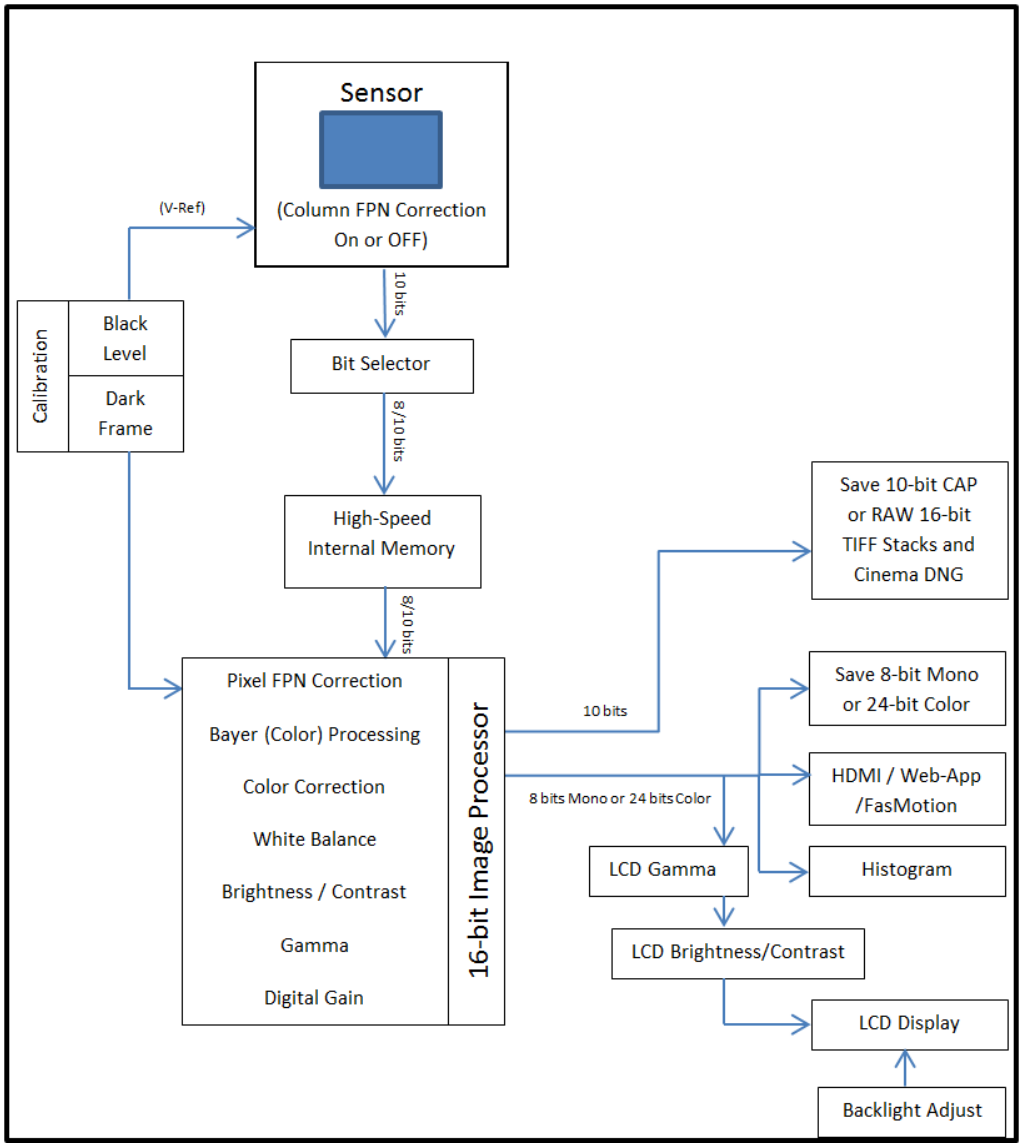
Record Rate (FPS)	60	125	250	500	1000	2000	4000	5600
Playback Rates	5	5	5	5	5	5	5	5
	10	10	10	10	10	10	10	10
	15	15	15	15	15	15	15	15
	30	30	30	30	30	30	30	30
	60	60	60	60	60	60	60	60
		120	120	120	120	120	120	120
		125	125	250	500	1000	2000	2800
			250	500	1000	2000	4000	5600

4-10 Image Processing

Image Processing Pipeline.

The TS3 image processing begins in the LUPA1300-2 sensor, where on-chip FPN corrections occur (if enabled) and the Black level is set using data collected during calibration Pixel data, also collected during calibration is used for Pixel FPN correction (if nabled). (See “4-6 Black Level Calibration on page 27.) The TS3 does more image processing, some of which can be controlled by the operator. To better understand how this works, please refer to “Figure 4-13: Image Pipeline”.

Figure 4-13: Image Pipeline



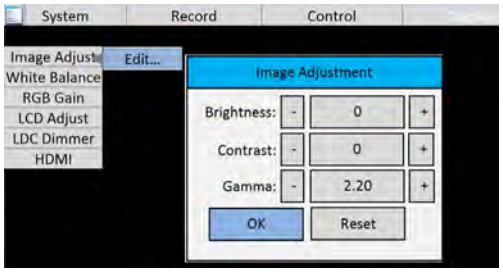
The 10-bit sensor output goes to the Bit Selector, then to internal high-speed memory. This selection is made by the user when bit depth is selected. (See”4-4 Setting Bit Depth” on page 25.)

The path for all displayed images and the input to the histogram is: Sensor, to Bit Selector, to Image Processor, to Display / Histogram. It is always 8-bit Mono or 24-bit Color. Live images pass through from high-speed memory to the image processor immediately. Captured images are saved in high-speed memory until the camera powers down or the images are written over.

- Images in the internal high-speed memory have not yet gone through the image processor. This means that the image processing settings have NO effect on the images in high-speed memory--they only affect the images as they are saved or displayed.
- Images in high-speed memory may be viewed or saved multiple times with different settings.

- Live images seen on the display ALWAYS go through the image processor.

Figure 4-14: Image Processing Options



User Control of Image Processor

- Bayer (Color) processing (color cameras only) is done in order to display a color image. The user may elect to save images that have not gone through Bayer colorization by choosing to download a RAW format (See “4-12 Saving Images to Mass Storage”.)
- Color Correction is controlled via “White Balance” in the Display menu. You may choose from several color temperatures: Daylight (5600K), Tungsten (3200K), and Fluorescent (4100K) and Normal setting 1:1:1 (all channels at nominal gain). There is also a “Custom” setting used to white balance using a gray target and an RGB gain dialog for further manual adjustment. See “4-11 Custom Color Correction .
- Brightness and Contrast are controlled via Display / Image Adjust. Users select levels from -100 to +100 (default = 0) using the +/- buttons or by clicking on the number in the edit box to open a keypad.
- Gamma is also adjusted in the Display / Image Adjust dialog. Levels range from 0.20 to 5.00. Gamma 2.2 is the default as it is the most common display gamma for monitors. For a linear display choose a gamma of 1.00. (See also “3-3 Controlling the Displays” on page 15.)

Setting Image Processing Options:

Figure 4-15: White Balance Dialog

1. Navigate to the Display Menu
2. Select the image processing option you wish to change: Brightness, Contrast, or Gamma.
3. Experiment with the values in each of these controls to get the best possible image.
4. You may wish to open a histogram (DISP Button) for reference as you use these controls.

Note: Making a selection from this menu only affects the Displayed image and any (non RAW) images saved to mass storage devices. It does not a ect the either the 8-bit or 10-bit images as they are recorded into the TS3’s high-speed internal memory. **Adjustments made here may be done before and/or after the imagery is captured.**

Note: All image processing is done using 16-bit math. If 8 bits are recorded, they will be used as the upper 8 bits of the 16-bit calculations by the image processor. The upper 8 bits of the results are then used as an output. Similarly, if 10 bits are recorded, they will be used as the upper 10 bits of the 16-bit calculations. This is true regardless of the output bit depth, thus the lower two bits of the 10 bits recorded are used when computing color corrections and image adjustments, even if you are viewing or downloading 8/24-bit formats.

4-11 Custom Color Correction

When the preset White Balance options, Daylight, Tungsten, and Fluorescent, do not give you the color reproduction you need, there are a couple of other options available:

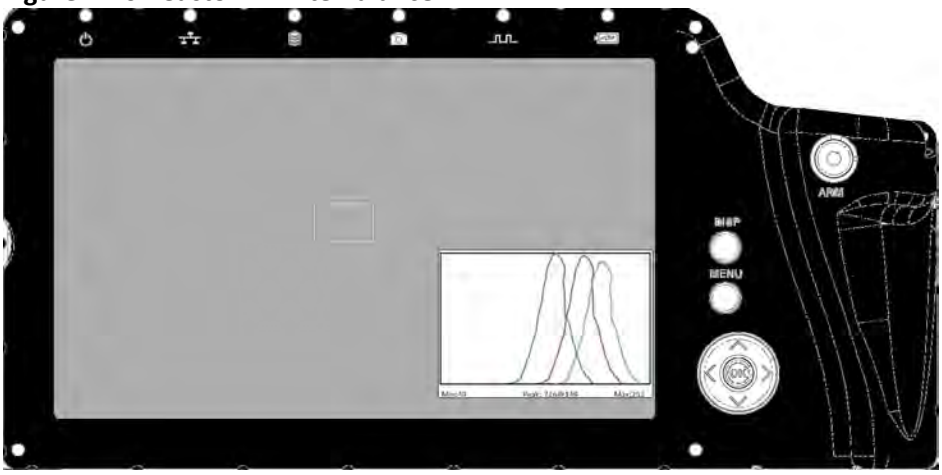
The Custom item in the Display/White Balance menu allows you to set the color correction via a gray card or neutral gray object.

To use Custom White Balance:

1. Click on the “Custom” button in the White Balance menu. A rectangular reticle will appear in the middle of the LCD display and a special histogram will appear at the lower right. (See “Figure

4-16: Custom White Balance" on page 34.)

Figure 4-16: Custom White Balance



2. Center the reticle (the white box in the center of the image) on a neutral gray object in the field of view. In this instance we are using an 18% gray card, which is the recommended target. Most often the card will only fill portion of the field of view--it only needs to fill the reticle It is important that the card, or other neutral gray object is located close to the objects of interest and is exposed to the same light as the objects you are going to image.
3. Adjust the lens aperture so that the histogram shows the pixel values grouped high (to the right side of the box), but not saturated. It is important that the high pixel value is less than 255. Notic on the example here, that the RGB peaks are not well aligned and that the Blue peak is farthest to the left. This means that the color is skewed slightly towards the yellow, the complement to blue.

Note: The histogram used with Custom White Balance represents only the area of the reticle, not the whole image.

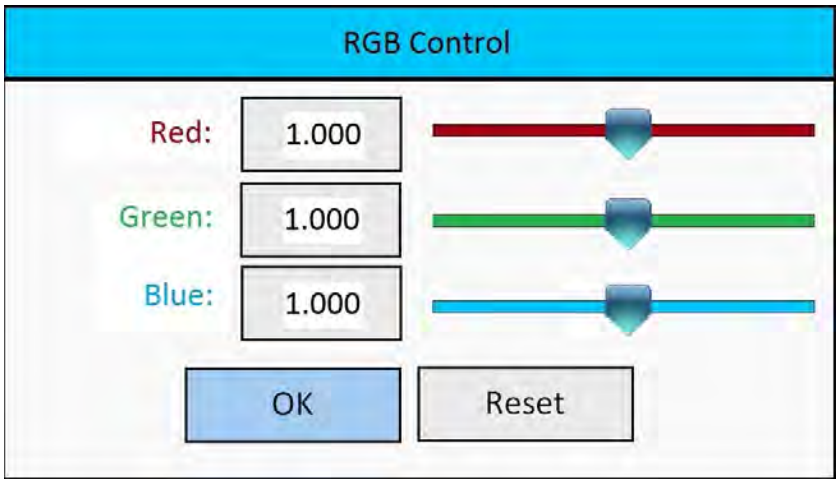
Note: For more information regarding TS3 Histograms please refer to “Application No e 1: Histograms” on page 93.

4. Press the Trigger button. You will immediately notice an difference in the color.

Using RGB Gain Controls

Another option for addressing color correction is via RGB Gains. It is recommended that you use the RGB gains sparingly and as a final “tweak” to make subtle changes to the color. The best use of this is to get the color as close as possible using the White Balance presets or Custom options before adjusting the RGB gains.

Figure 4-17: RGB Control Dialog



To use RGB Gain:

1. Navigate to the Display/RGB Gain menu and open the dialog box.
2. For any color gain you wish to increase, move the slider to the desired position. Remember to use the D-Pad for fine adjustment.

Note: Remember that in the Bayer pattern, 1/2 of the pixels are green, 1/4 are blue and 1/4 are red. Whenever you change gain values you will be adding some noise to the image. It is best to avoid using any more gain than you need to, and to take special care with the green channel as it represents half of the pixels in the image.

4-12 Saving Images to Mass Storage

Image sequences are saved either as Patition Captures (CAP files), or AVI videos, in which one file contains all the frames of the sequence, or as TIFF, DNG, JPEG, or BMP stacks, which are collections of files, one file per frame of imagery. Partition Capture files (CAP) include all the aw image data in a proprietary uncompressed format. The file save options change depending on whether or 8-bit or 10-bit image data has been written to internal high-speed memory:

Table 4-5: Image File Save Options

10-bits recorded	8-bits recorded
TIFF (8-bit M /24-bit C) or RAW TIFF (16-bit)	TIFF (8-bit M / 24-bit C) or RAW TIFF (8-bit)
DNG (16-bit Raw format)	DNG (8-bit Raw format)
BMP (8-bit M /24-bit C)	BMP (8-bit M/ 24-bit C)
AVI (8-bit M /24-bit C)	AVI (8-bit M / 24-bit C)
JPEG (8-bit M /24-bit C)	JPEG (8-bit M / 24-bit C)
CAP (10-bit Raw format)	CAP (8-bit Raw format)

Note: CAP files are only availble on cameras with SSDs, SN A0 and higher.

Calculating file sizes for TIFF and BMP images is very simple:

Resolution x Bit de th/8 = approximate BMP or TIFF file si e in Bytes

(to convert Bytes to KB divide by 1024)

For example a 1280 x 1024 Mono BMP or TIFF is:

1280 x 1024 x 8 / 8 = 1,310,720 bytes = 1,280K

A 1280 x 1024 16-bit RAW TIFF/DNG is:

1280 x 1024 x 16 / 8 = 2,621,440 bytes = 2,560K

CAP files a e always the size of the current buffer (session size).

The actual file size of a 1280 x 1024 mono BMP or TIFF is about 1281K (the additional 1K or the file header). The actual size of 16-bit RAW TIFF is 2561K (again add an additional 1K or the header).

Note: The RAW 16-bit TIFF saved from the camera actually has 10 bits of image data. The 16-bit format is used for compatibility reasons.

Calculating file sizes for AVI and JPEG images is much more difficult. The compression is often approximately 10x to 20x, but it can be much greater for images with little content, and it can be much less for very complex images.

RAW images are not colorized, so Mono and Color images are the same size. Colorization increases file size 3x because 8 bits are saved for each of red, green, and blue channels.

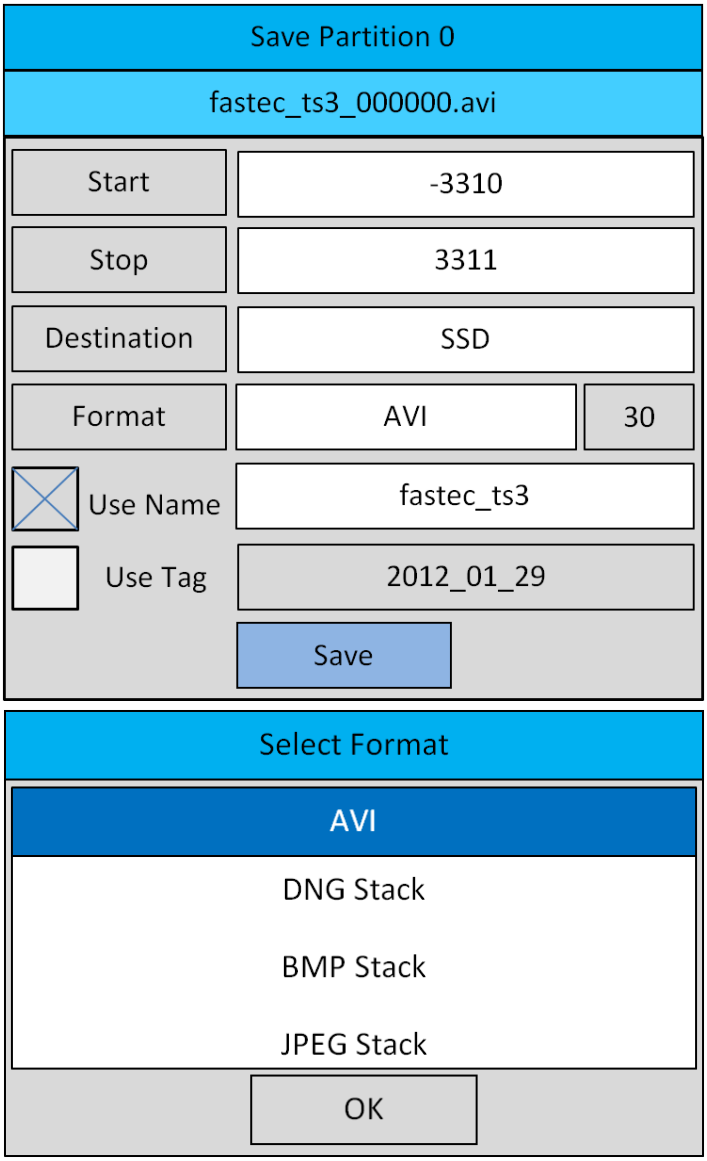
To **Save** a recording to a connected mass storage device on the TS3:

1. Navigate to the Review Menu
2. Select Save. The Save dialog box will appear as in “Figure 4-15: White Balance Dialog”. The Start and Stop frames for the Save may be edited.

Note that the frame numbers initially shown in the dialog box will be the actual start and stop frames for the entire capture *unless* the Cut In and Cut Out buttons were used during Review. If you are not sure what the actual beginning and end frame numbers for the video are, you can find them on the far left / far right sides of the record bar. (See “Figure 4-10: Recording Progress: Triggered TS3”.)

1. Selecting “Destination” will open a dialog box for selecting the mass storage device to save to.
2. Select “Format” to select the file type. Once you select a file type from the list, the OK button will turn blue. Press the left far arrow to enable a RAW format, if available, depending on the bit-depth recorded. (See “Table 4-5: Image File Save Options .)
3. The default file name format for the image stacks is Frame_000000.<TYPE>. If you would like the name to include the camera name, Select Use Name in the dialog. The resulting file name format for the example would become TS3-11_000000.<TYPE>.

Figure 4-18: Save Dialog Boxes



4. If you would like to add a tag to the name, select Tag. The Tag may be edited. Using the Tag in the example, the file nam becomes 2011-10-11_000000.<TYPE>.
5. Both the Name and the Tag may be used, in which case the file name becomesTS3-11_2011-10-11_000000.<TYPE> in the example.
6. If AVI files a e saved, the default file name is ts3_000000.AVI. The Use Name and Use Tag options are also valid for AVI files in which case the resulting file names are. TS3-11_000000.AVI, or 2011-10-11_000000. AVI, etc. If the file size exceeds the 4GB limit for 32-bit file systems, the TS3 will make a second file or the remainder of the imagery. (MiDAS and other players will play the video as one.)

When the TS3 saves imagery to mass storage it creates the following:

- DCIM. This is an industry standard directory name for Digital Camera Images.
- 100fastc. This is a sub-directory under DCIM.
- ts3_000000. This is the first sub-directory under DCIM/100fastc, used for storing image stacks.
- hs-video. This is the directory that all AVI files are written to.
- <filename> txt. For each download, the camera creates this text file. In it are the camera setup values, including resolution, frame rate, camera name, time stamp for the capture, image processing values, color processing values, etc. (See “Appendix G: Contents of Frame.txt file .)
- <filename>.c g files. This is a binary file used for MiDAS player so that it can properly play the image files as a movie.

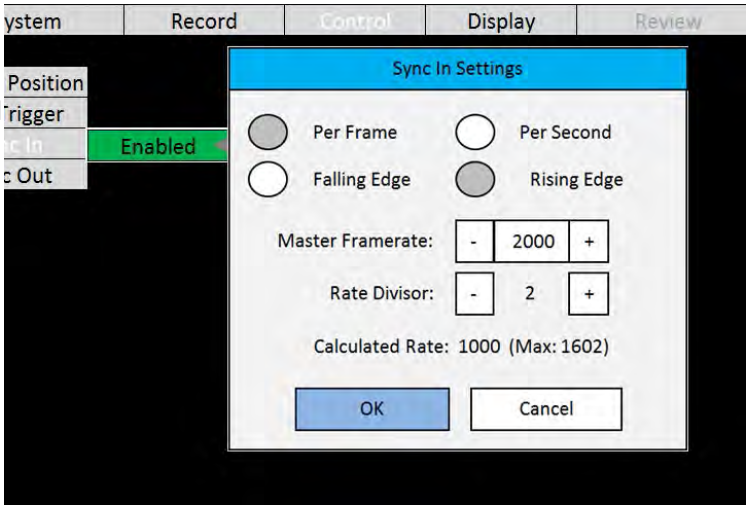
Note: Image files may be saved multiple times using different formats,different start and stop points, and different image processing options (brightness, contrast, gamma, color, etc.). If 10-bit images have been captured, imagery may be saved multiple times using different bit-depths.

5 Synchronizing Cameras

Note: Please refer to "Appendix D: Power and I/O Connections" on page 82 for electrical specifications. Do not experiment with these connections if you are unsure of compatibility with your source as they are very sensitive to over voltage and can be easily damaged.

5-1 Sync In

Figure 5-1: Sync In Settings Dialog



Per Frame:

The TS3 is easily synchronized to an external device such as another camera, or a precision timing generator. The "Per Frame" option is used when you wish the camera to capture at a rate of one sync-pulse per frame or greater.

To set up Sync-In:

1. Navigate to the Control Menu.
2. Select Sync In. There are two buttons: Enabled/Disabled, and another that may say "1-PPF, Rising Edge, Divisor=1"--or something similar.
3. Change the state of the first button to "Enabled" (green), then click on the second button to open the Sync In Settings dialog.

The touchscreen feature is implemented for this dialog. If it is enabled, you will be able to enter data with your fingertip. (See "3-2 Using the Touchscreen" on page 14.)

4. Select Rising Edge or falling edge depending on your preference.
5. Select Per Frame. (Per Second Synchronization will be covered in the next section.
6. Set the master frame rate. This is the speed in Hertz of the input signal. It is important that the input signal does not exceed this because this is the number the camera will use to calculate integration timing.
7. Set the rate divisor. In the example shown in "Figure 5-1: Sync In Settings Dialog", the desired frame rate is 1000, while the Master Frame rate is 2000, so a divisor of 2 is used.
8. Click on OK to accept the settings. The camera's frame rate will now be set at 1000 and all of the shutter settings are adjusted accordingly.

In this example, the Max (frame rate) is 1602. The camera's resolution was set at 800 x480. 1602 is the maximum frame rate for that resolution. If you wish to change your maximum frame rate, you must change the resolution in the record/Settings men

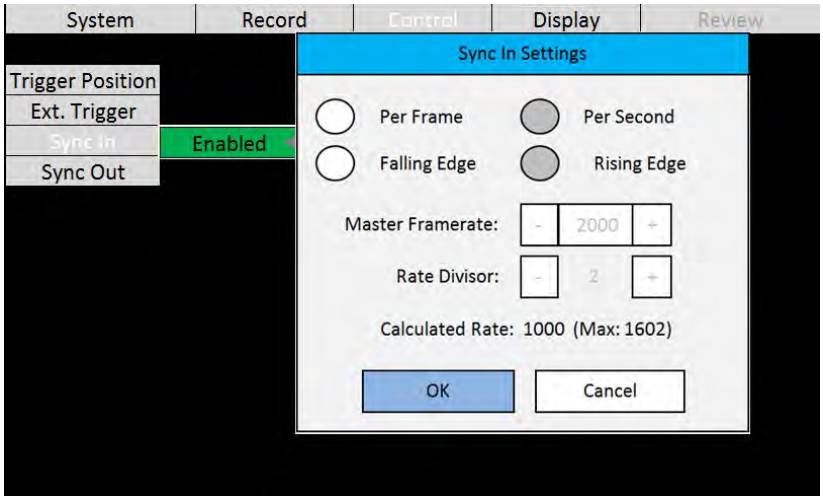
Note: With Sync In enabled, you will not get a live image unless a valid sync signal is present.

Per Second:

Many commonly available sync sources have a precision 1 Hz output. IRIG and GPS are two that are very often used with high-speed data capture.

The TS3 is able to utilize these signals for synchronization of cameras at any frame rate.

Figure 5-2: Sync In Per Second



To use Per Second Synchronization:

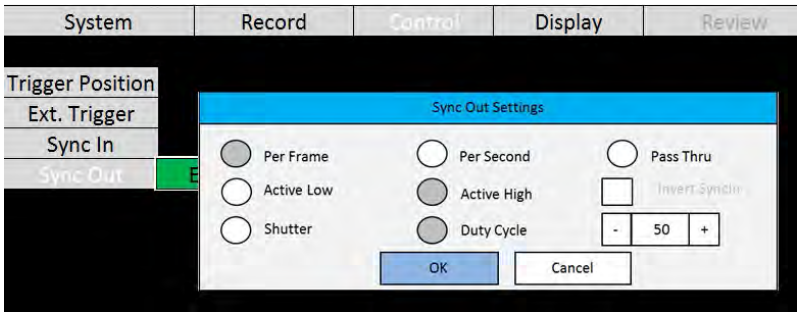
1. Navigate to the Control Menu and open the Sync In Settings dialog (as in the previous section)
2. Select "Per Second" in the dialog box. The Master Frame rate and Rate Divisor fields will gray-out.
3. The Calculated Rate will reflect the frame rate set in Record/Settings. If you wish to change those settings you will do those as for any normal recording.(See "4-1 Setting Frame Rate and Resolution" on page 22.)

5-2 Sync Out

Per Frame

External devices such as additional cameras, strobe lights, and test instruments may be synchronized via Sync Out pulses from the TS3. The "Per Frame" option output is one pulse per frame--the sync pulse rate is equal to the recording frame rate.

Figure 5-3: Sync Out Per Frame



To set up Sync Out:

1. Navigate to the Control Menu.
2. Select Sync Out. There are two buttons: Enabled/Disabled, and another that may say 1-PPF, Shutter, Active High--or something similar.
3. Change the state of the first button to "Enabled" (green), then click on the second button to open the Sync Out Settings Dialog.
4. The signal can either be **Ac ive High**, meaning the signal goes high when the shutter opens, or **Active Low**, meaning the signal goes low with when the shutter opens. Select Active High or Low from the dialog box.
5. The signal can either follow the Shutter (integration time) or you can select Duty Cycle and control the % of frame time (1/f ame rate) for the active portion of the signal using the number box provided.

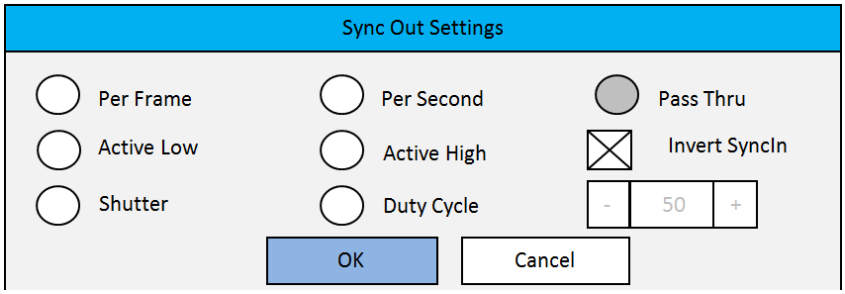
Per Second

If you choose the "Per Second," the camera will output a 1Hz signal. The only active options in this mode are Active High and Active Low.

Pass Thru

When you select Sync Out Pass Thru, the signal received on Sync In is sent to Sync Out. The only setting that affects this signal is the Invert Sync In option which simply inverts the signal.

Figure 5-4: Sync Pass Thru



5-3 Master/Slave Setup

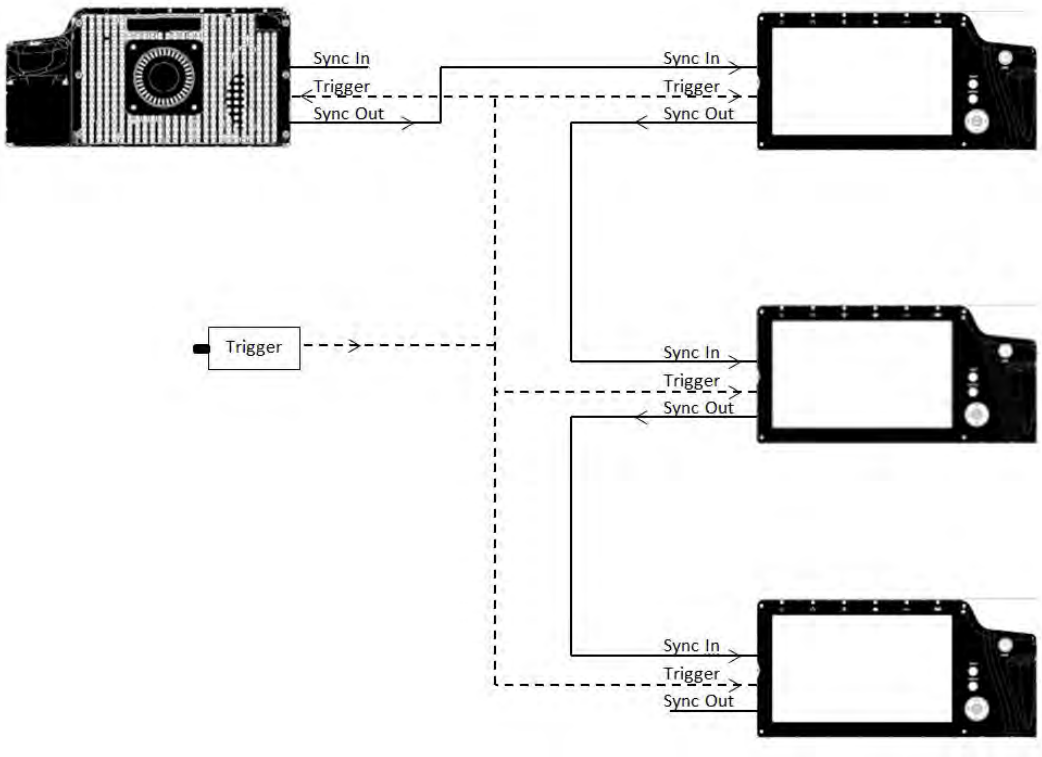
There are many possible configurations used to synchronize groups of cameras.
The Master/Slave configuration is often used when a group cameras is used to capture multipl synchronous views of an event that is not driven by a clock or PLC. For example, when studying animal or human kinetics, the subject (animal or human) is not supplying a sync signal for the camera system, so the camera system uses its own: Sync Out from a Master camera.

In this configuration any camera may be used as the Master.

Commonly, all cameras are set to the same Frame Rate and Resolution are triggered together, and integrate frames together (synchronize frame start times). For this setup:

- Enable External Trigger for all cameras and use the same polarity for all.
- Sync Out from the Master camera is set to “Per Frame”
- Sync Out for the Slave cameras are set to “Pass Thru.” Invert Sync In is **not** selected.
- Sync In for the Slave cameras Master Frame rate is set the same as the Frame rate of the Master camera.
- Choice of Shutter or Duty Cycle does not matter.

Figure 5-5: Master and Slave Cameras



- If the Master Sync Out is Active High, then the Slave Sync In must be set for Rising Edge. If Master Sync Out is Active Low, then the Slave Sync In must be set for Falling Edge.

NOTE: For the “common” setup as well as for variations listed below, always make sure that the Post Trigger portion of the recording time for the Master camera is equal to or greater than each of the Slave cameras. This is important because Sync Out pulses cease with the completion of the capture, so the Master camera must continue recording until all Slave cameras complete their recordings.

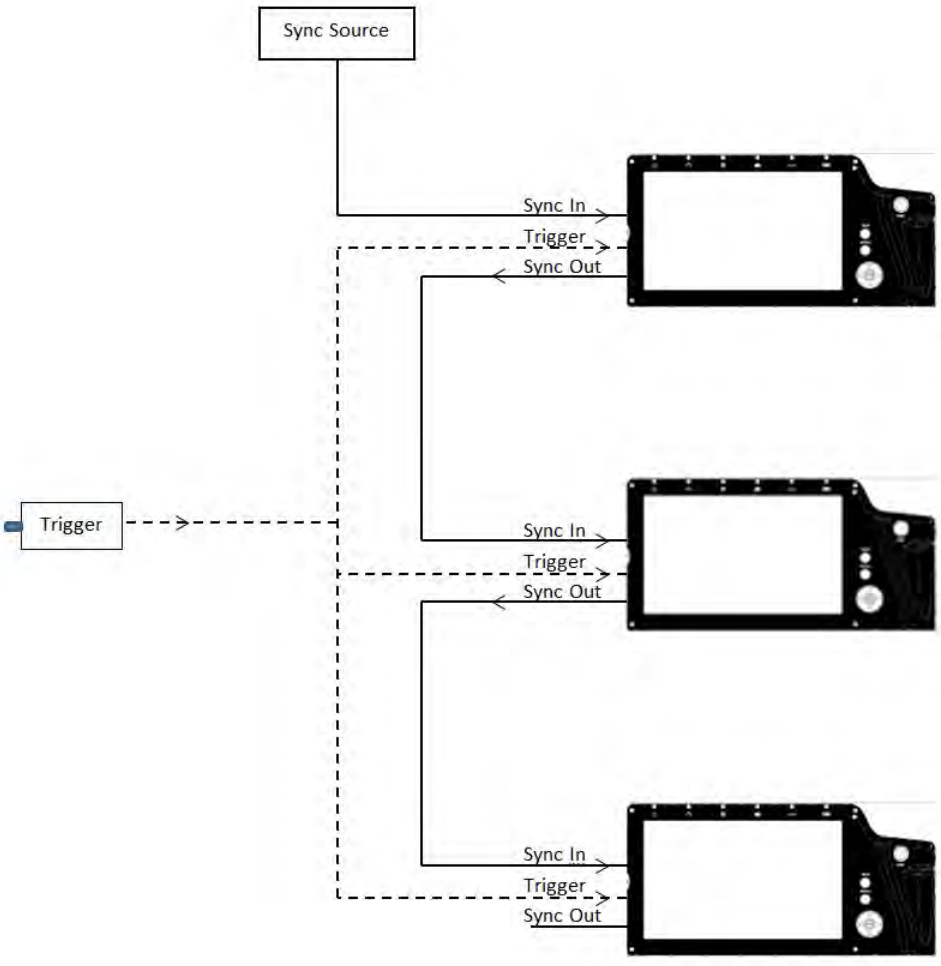
Parameters that affect post trigger recording time include: Trigger position Resolution Bit depth, base internal Memory (camera model), Frame rate.

Variations on Master/Slave:

- Use a slower frame rate for one or more of the slave cameras by using a Rate Divisor in the Sync-In setup. (Make sure to make allowance for the extended time per the note above.)
- Extend the overall record time by adjusting the trigger position or all cameras. For example, set the Master to a Start trigger, the first Slave to 10%, the second Slave to 50%, etc. This would also be used if the subject is progressing through the different cameras’ fields of view, as a runner running by each camera in sequence.
- Run cameras out of phase with each other. Higher effecti e frame rates can be simulated by running cameras out of phase with each other. This is usually done by using Duty Cycle in Sync Out, for example: if you set the Duty Cycle for 50% and invert the signal, the next camera in line will run 180 degrees out of sync.

5-4 External Source Sync

Figure 5-6: External Sync: Local Grouping



Synchronizing to an external source is most common in applications where a preferred sync pulse is available such as one from a PLC, IRIG, or GPS.

NOTE: Please refer to “Appendix D: Power and I/O Connections” on pa e 82, for electrical specifications.

This sync pulse may be used for a localized group of cameras, in which the cameras are connected as in “Figure 5-6: External Sync: Local Grouping” on page 40 is commonly used. The cameras may also be placed far apart, in which case they are connected to a distributed sync signal as in “Figure 5-7: External Sync: Distributed Grouping”.

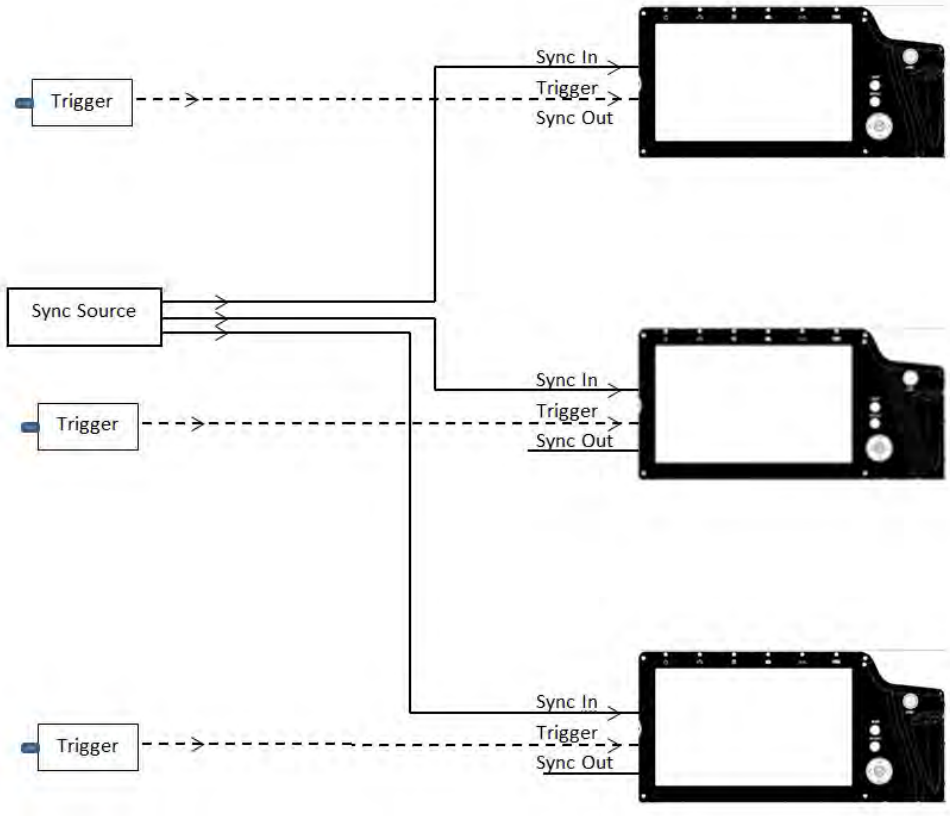
In the case of using a PLC or other local clock, you will need to know the polarity and frequency of the signal in order to set the cameras up. Optimum frame rates can often be derived using the Rate Devisor function

When using IRIG or GPS as an input, you will first need to derive a 1Hz signal from the source, then use the Per Second option. This gives you complete flexibility with respect to frame rate: you can select any frame rate you wish to use.

Note: full IRIG and GPS implementation is planned for a future release.

Triggering in a distributed grouping may either be implemented locally via switch, camera button, or software, or it may be available along with the sync as a distributed signal.

Figure 5-7: External Sync: Distributed Grouping



6 Using the Web App

6-1 Web App Overview

The Web Application is a utility built to the TS3 which makes control of the camera possible by any networked computer running an Internet Browser. No software needs to be loaded on the computer. It provides the user all the utility vailable through the buttons and touch screen of the TS3.

Enter the Web App by typing either the network-connected TS3's camera name or IP address into the address bar of an internet browser (See "3-5 Using the TS3 with a PC" on page 17 .

Figure 6-1: Address bar (Chrome)

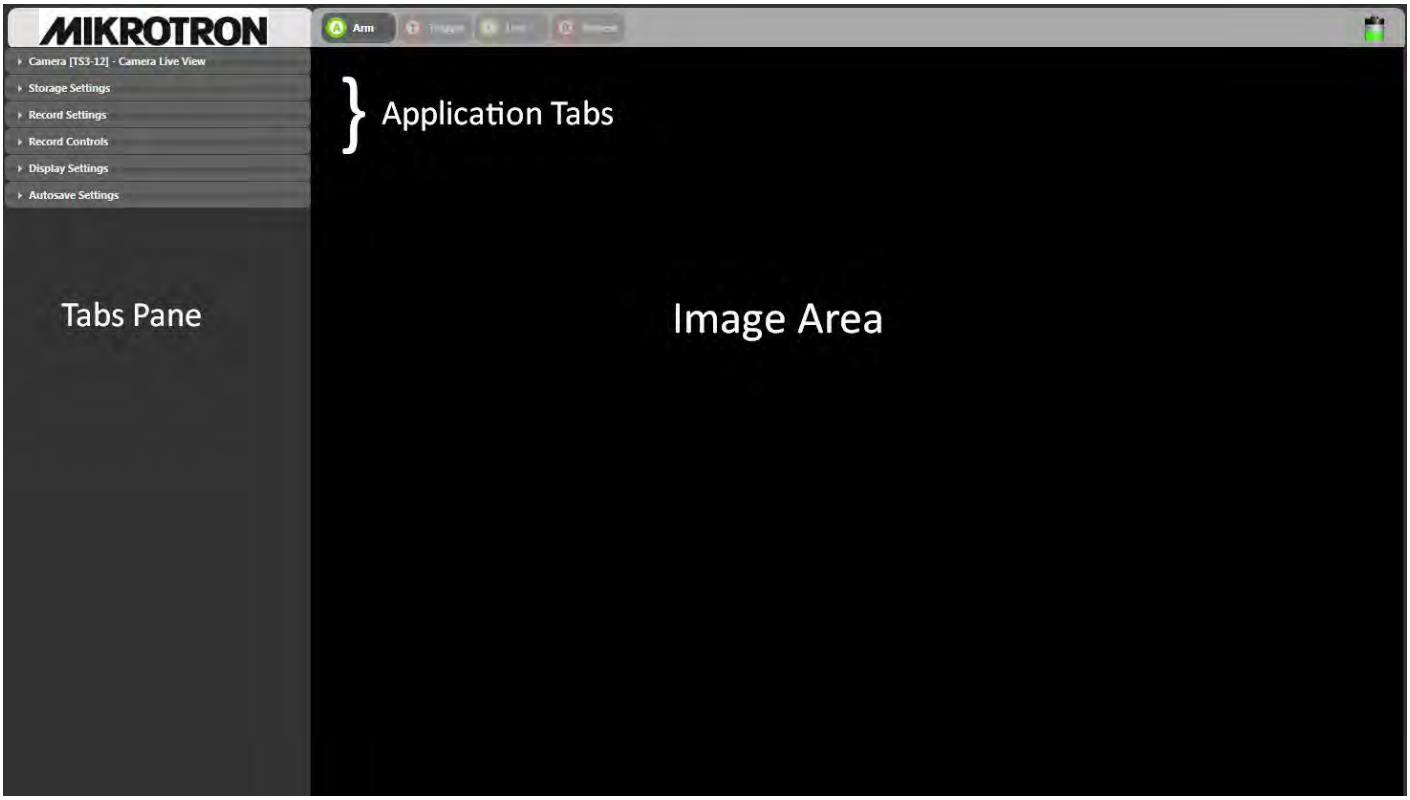
The Application Window is comprised of:

- A Control Bar at the top, which includes Arm and Trigger buttons as well as the Battery Icon
- 6 Application Tabs, including the Camera Tab, Storage Settings Tab, Record Settings Tab, Record Control Tab, Display Settings Tab, and the Video Review Tab, which is present only when there is captured video available for Review.
- The Tabs Pane. When you click on a Tab it will open vertically along this pane. Tabs beneath the opened one will slide down the pane.
- The image area. This is where Live or Captured imagery appears.

In the figure below, TS3_12 is connected in Live Mode.

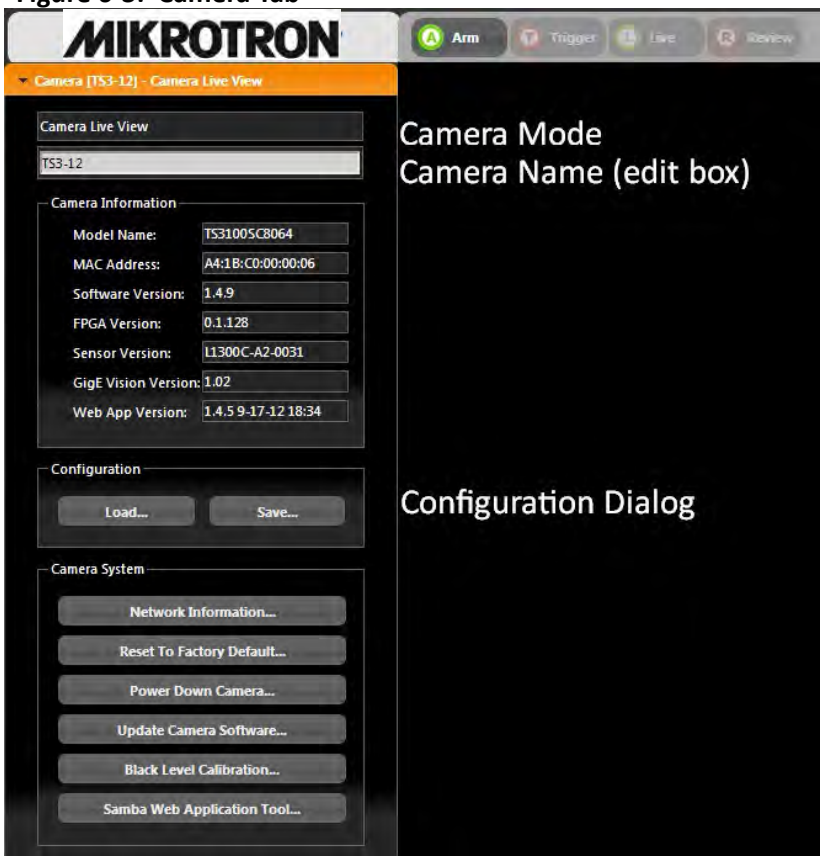
Notice that the Camera Name is displayed in brackets [ ] on the Camera Tab and that the camera's mode of operation (in this ase "Live View" is listed there as well. The Trigger Button is absent because the camera has not yet been armed. The Review Tab is also absent as there is no video to review.

Figure 6-2: Application Window Camera Tab



6-2 Camera Tab

Figure 6-3: Camera Tab



Clicking on the Camera Tab exposes its contents and shifts the other Tabs down the Tabs Pane below it.

All tabs are always accessible, with the exception of the review tab, which is only available in Review Mode (after video has been captured). Clicking on the Camera Tab a second time closes it. Opening another tab will also close the current one.

The Camera Tab always displays the Camera's current Mode of operation

These modes include:

- Camera Live View, in which a live image is displayed in the Image Area.
- Camera Armed. This is the state of capturing pre-trigger frames.
- Camera Triggered. The camera is capturing post-trigger frames.
- Camera Video Review. The camera has finished ecording. The captured video appears on the screen. Playback controls appear beneath the image window. (See "Web-App Review and Save" on page 48.)

You will also notice that when the camera is controlled via the Web App, the Mode script will say, "Waiting or Camera to Arm" or Waiting or camera Trigger," etc. for a very short time until the app gets confirmation back from the camera that its state has changed.

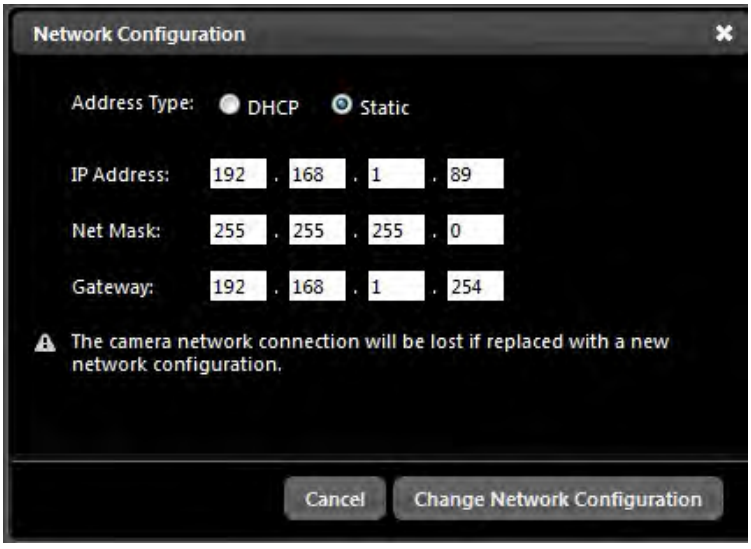
If the computer loses communication with the camera, the Mode script will say "Camera Load Failure."

To change the camera name: highlight the camera name in the Edit Box and type in the new name. Press "tab" to accept.

The Camera Con iguration may be loaded or saved via the Configuration Dialog. It may be reset using The "Reset to Factory Default..." button.

The Network Con iguration of the camera may be viewed by clicking on the "Network Information" button.

Figure 6-4: Network Configuration Dialog


Network Configuration
Address Type: DHCP Static
IP Address: 192 . 168 . 1 . 89
Net Mask: 255 . 255 . 255 . 0
Gateway: 192 . 168 . 1 . 254
The camera network connection will be lost if replaced with a new network configuration.
Cancel
Change Network Configuration

6-3 Storage Settings Tab

The Storage Tab is used to Explore the memory storage devices connected to or installed in the camera as well as the Internal (high-speed) memory used for capturing video.

The ability to create multiple partitions in internal memory is not enabled at the time of this writing. When this feature is enabled, you will be able to choose the number of partition and select the active partition using this dialog.

The upper portion of this Tab is for Exploring the Storage Media.

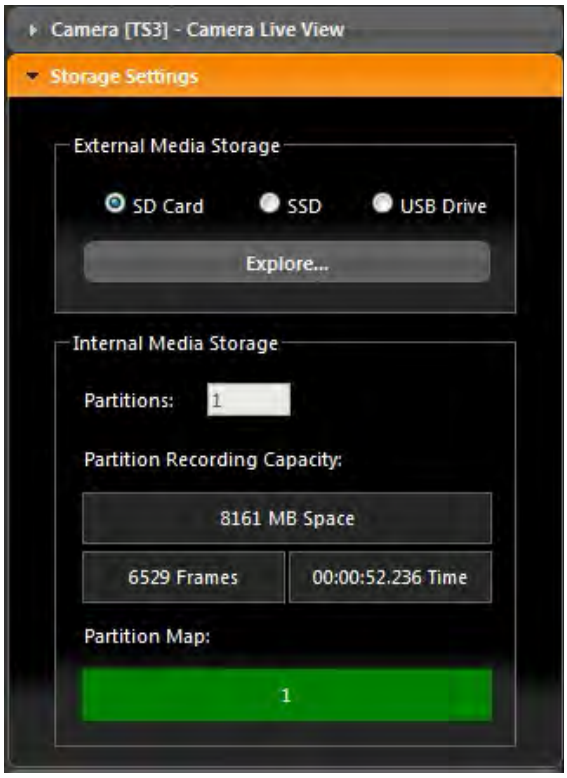
When exploring

1. Use the radio buttons to choose the storage device to manage-- SD Card (SDHC), SSD (internal drive), or USB Drive.
2. Click on Explore to open an Explore window for the device.
3. If you wish to explore another device from the explore window, click on “Parent Directory” to see the list of other devices.

The Explore window will look slightly different depending on the web browser and operating system you are using, but the content will be the same for all. (See Figure 6-6.)

Notice that in the example, we are looking at the directory of the SD Card: .../media/sdcard. Click on “hs_video/” to find the stored video files. Click on "dcim/” then “100fastc/ to find stored stills and video stacks.

Figure 6-5: Storage Settings Tab

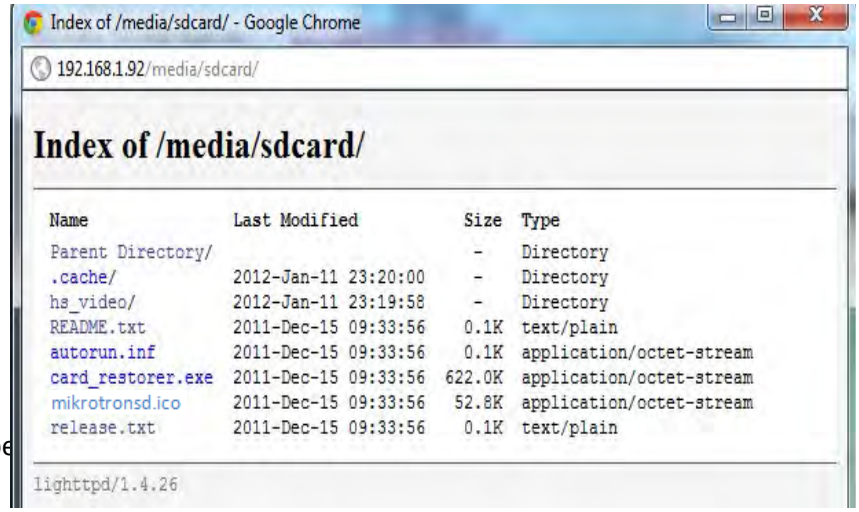


To play a video, click on the file name and the video will open in the default media player. Large stored videos may play slowly when opened this way. You may wish to copy them to a computer drive first, and play them from there.

To open a still, click on the file name and the still will open in the explore window. To return to the last directory, right click in the window (but not on the image) and select “back.”

To copy a video or still to a computer drive:

Figure 6-6: Explore Window


Index of /media/sdcard/ - Google Chrome
192.168.1.92/media/sdcard/
Index of /media/sdcard/
Name Last Modified Size Type
Parent Directory/ - Directory
.cache/ 2012-Jan-11 23:20:00 - Directory
hs_video/ 2012-Jan-11 23:19:58 - Directory
README.txt 2011-Dec-15 09:33:56 0.1K text/plain
autorun.inf 2011-Dec-15 09:33:56 0.1K application/octet-stream
card_restorer.exe 2011-Dec-15 09:33:56 622.0K application/octet-stream
mikrotronsd.ico 2011-Dec-15 09:33:56 52.8K application/octet-stream
release.txt 2011-Dec-15 09:33:56 0.1K text/plain
lighttpd/1.4.26

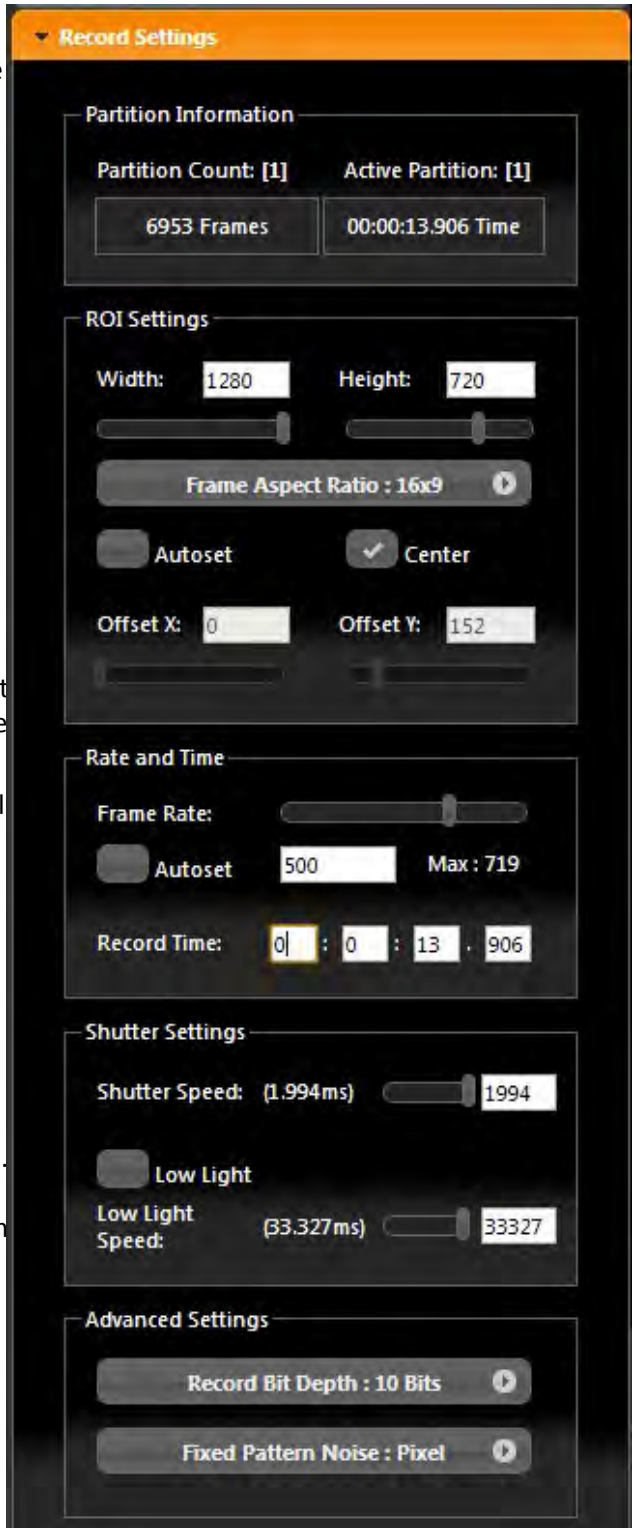
1. Right click on the file you wish to ope A context menu will open with a list of actions. The list varies depending on the browser you are using.
2. If using Chrome, Firefox, or Safari, select “save link as...” or, if using Windows Internet Explorer, select “save target as...”This will open a dialog box allowing you to navigate to the drive and directory you wish to save the file to.

Note: Only one file may be copied at a time. No files may be either deleted or moved via the Web App. In order to copy groups of files and directories (file stacks, etc.) open the camera in a separate Explore window. (See “3-5 Using the TS3 with a PC” on page 17

6-4 Record Settings

The Record Settings Tab is analogous to the Record Menu on the TS3 camera GUI. It contains the controls for setting ROI (Region of Interest), record Rate and Time (Frame Rate and Record TIme), Shutter Speed, and Bit Depth, and FPN Control.

Figure 6-7: Record Settings Tab



Setting ROI:

1. If you wish to use one of the standard aspect ratios 4:3, 5:4, or 16:9, click on the Frame Aspect Ratio bar and make your selection from those choices. If wish to select a custom aspect ratio, select that choice from the same pull down menu.
2. If you are using anything but a “Custom” for aspect ratio, you can adjust either width or height and the other will adjust automatically. You can either use the sliders or the edit boxes to make your selection. If you use the edit box, hit the “Tab” key on your computer keyboard or click outside the box to complete your entry.
3. Select the “Autoset” box if you wish the camera ROI set automatically for the largest resolution possible at the selected frame rate.
4. Select the “Center” box to center the ROI to the optical center. If this is unchecked, you may set the ROI offset using the O set X and Y edit boxes (See “Figure 4-2: Advanced Record Settings” on p e 23).

Setting the Frame Rate:

Either move the Frame Rate slider or edit the associated text box to change the frame rate.

The frame rate is limited by the resolution. There is a Max frame rate number next to the edit box letting you know what the maximum frame rate is for the current resolution. Clicking on the “Autoset” button will set the frame rate to that maximum number possible with the current resolution setting.

Setting the Shutter Speed:

Set the shutter speed by moving the slider.

The minimum shutter speed (maximum sensor integration time) is limited by the frame rate. It is .006ms less than 1 frame time or 1/(frame rate -.006ms). The maximum shutter speed (minimum sensor integration time) is always .002ms.

Low Light: (See “Figure 4-4: Low Light Menu” on page 25.)

The Low light feature lets you use shutter speeds up to 33.326ms for framing an focusing the camera prior to image capture. (During image capture the shutter speed will revert to its normal setting.

Click on the Low Light check box to enable it. Use the slider to set the shutter speed.

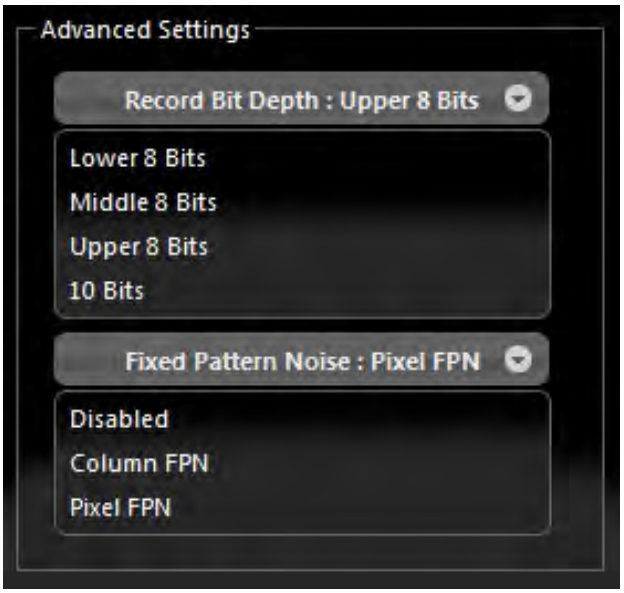
The Record Settings Tab, Advanced Settings x has one drop down menu for Record Bit Depth and another for Fixed Pattern Noise.

Select Bit Depth for Recording:

(See “4-4 Setting Bit Depth” on page 25.)

Note that if 10 bits are selected for the recording, the recording time will be shorter, but you will have the added flexibility of selecting which 8 bits to view in Review or Save. (The bit selection drop down menu will appear in the Display Settings Tab.

Figure 6-8: Record Settings Tab--Advanced Settings



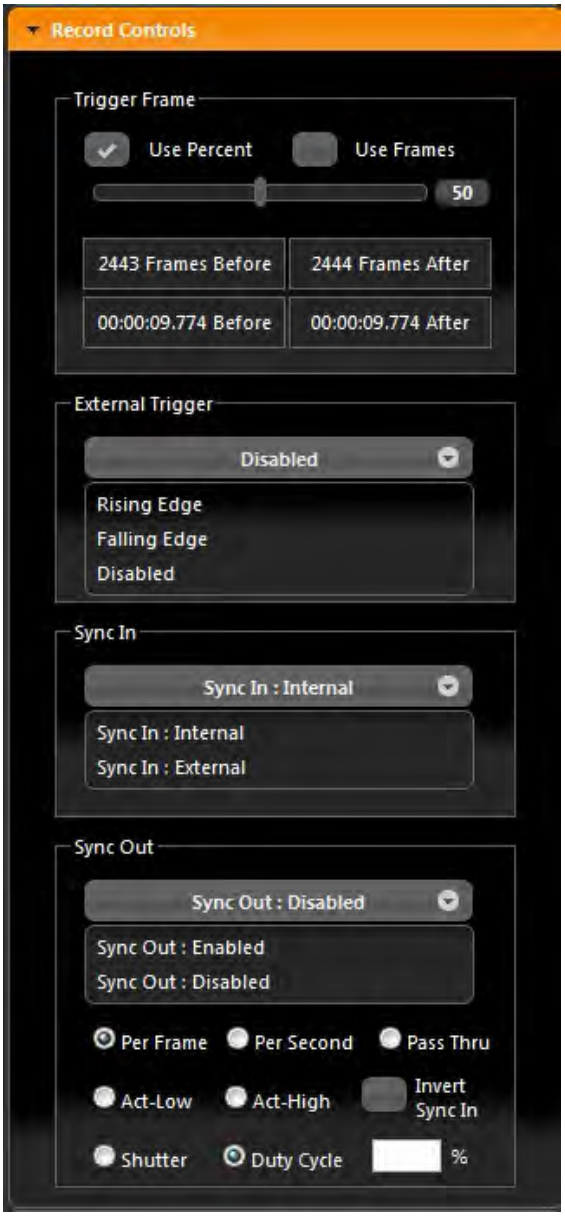
Select FPN Setting:

FPN selection (Disabled / Column FPN / Pixel FPN) can be done from the Web-Application via the Advanced Setting menu, but Calibration must be done from the camera. (See “4-6 Black Level Calibration” on page 27.)

6-5 Record Controls

The Record Controls Tab of the Web-App is shown in Figure 6-9 with the External Trigger, Sync In and Sync Out pull down menus open.

Figure 6-9: Record Controls Tab



Setting the Trigger Position:

The trigger position is set via slider. There is much finer control of the trigger position using the web-App than can be had on the camera GUI.

External Trigger:

Please refer to “Appendix D: Power and I/O Connections” on page 82 for specification for all electrical connections, including External Trigger, Sync In and Sync Out.

Select Rising Edge, or Falling Edge to enable the External Trigger. Use Falling Edge for a simple switch closure.

Sync In and Sync Out:

NOTE: If Sync in is enabled you will not see any Live or captured imagery unless there is a valid Sync In signal.

All of the options for camera synchronization are selectable on this menu.

Please refer to “5 Synchronizing Cameras” on page 37 for detailed descriptions of the options

6-6 Display Settings Tab

"Figure 6-10: Display Settings Tab", is shown with the /Bit Depth and White Balance selection boxes open.

Settings in this Tab control displayed images, both Live and in Review, and all saved images except the RAW formats.

The Display **Bit Depth** selection box will only be present when the camera has been placed in 10-bit mode in the Record Settings Tab. (See "Figure 6-8: Record Settings Tab--Advanced Settings.) For more detail on bit selection see "4-4 Setting Bit Depth" on page 25.

Select **White Balance*** preset according to the available light.

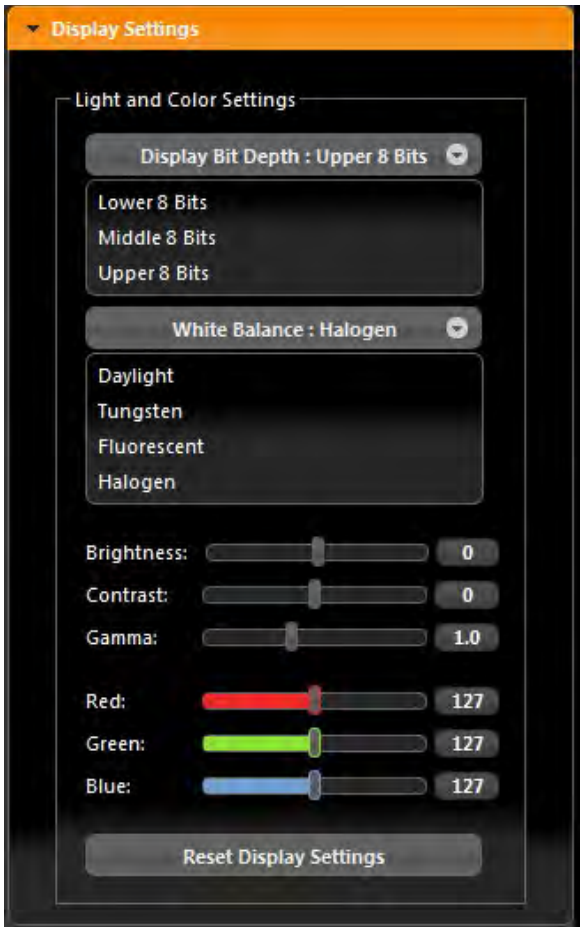
The sliders used for **Brightness, Contrast, and Gamma** you control over the same range as with the presets in the camera, but it is a much finer control.

The color sliders* give you control over the RGB gains. It is advisable to use the color sliders with a grey card to get good color balance:

1. Frame the camera image on a neutral gray object. (A gray card, piece of white paper, white wall etc.)
2. Turn on the histogram on the camera display.
3. Adjust the light or F-stop so that the histogram shows most pixel values in mid range. You will see a separate peak for Red, Green, and Blue. Green will likely be highest.
4. Adjust the gains for Blue and Red up so that the peaks match the Green.

(* Color cameras only.)

Figure 6-10: Display Settings Tab



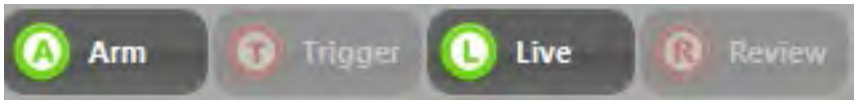
6-7 Arm, Trigger, Live, and Review Buttons

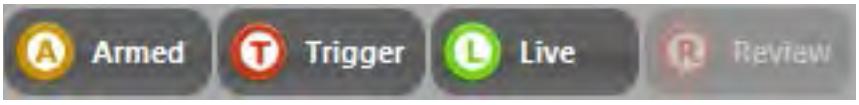
Use the Arm, Trigger, Live, and Review Buttons above the image window to control the state of the camera:

When the camera is in Live mode with no captured images in its buffer, the **Arm** and **Live** buttons will be enabled (bright) and the Trigger and Review buttons will be disabled (grayed).

Click on the **Arm** button whenever it is enabled and to go into Record mode. This will arm the camera, recording the pre-trigger frames.

Figure 6-11: Arm, Trigger, Live and Review Buttons





The Arm button will now turn Brown and change to "Armed." The Trigger button will become enabled. Clicking on the **Armed** (brown) button, will de-arm the camera (after a warning message), just like pressing the mechanical Arm button on the camera while the camera is recording.

Clicking on the **Trigger** button (or using the external hardware trigger, if enabled) will cause the

camera to record the post-trigger frames, thereby completing the recording. When the recording is complete the captured video is automatically opened in Review mode.

The **Live** button returns you to Live mode. If the camera is currently recording, there will be a warning message that proceeding will result in loss of unsaved video. If the camera is in Review mode, pressing the Live button will bring up an information box telling you that you are leaving Review and entering Live mode, but that captured video will remain in the camera until it is e-armed.

When in **Review** Mode, the Live and Review buttons act as a toggle between Live and Review. The current recording is not deleted until the amera is Armed or powered down.

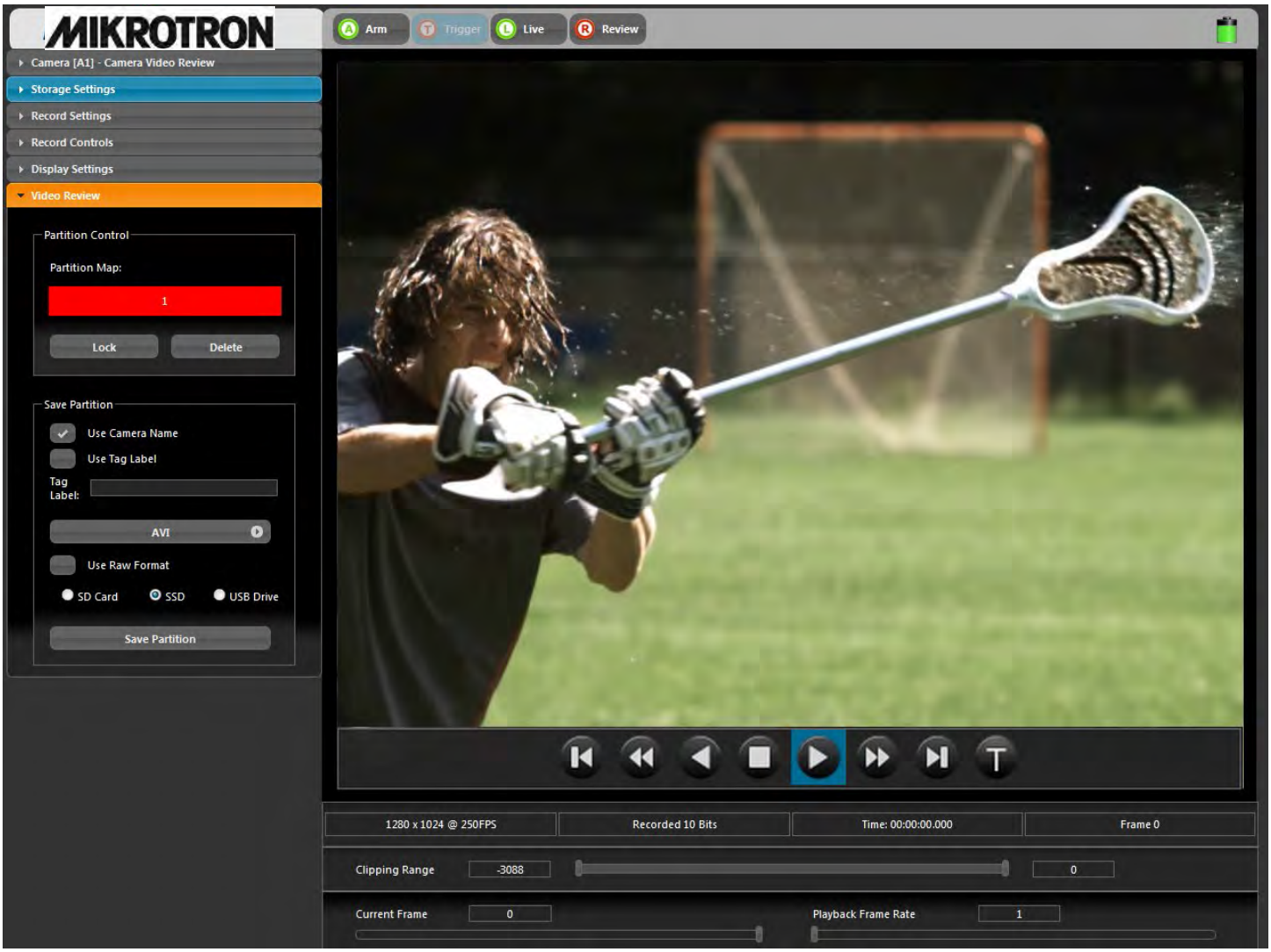
6-8 Review Tab

When in Review Mode, the Review Tab will open and the Playback controls will appear beneath the Image window.

Note: While in Review, the image may be adjusted using the controls in the Display Settings Tab. See “6-6 Display Settings Tab” on page 47.

The Play buttons, which only appear when the mouse cursor is brought over them, have the same functions as on the camera GUI (see “Table 4-3: Playback Control” on page 31), except that the Cut-In and Cut-Out points are entered by editing the Clipping Range boxes or by adjusting the slider between them. The clipping range is then used, as it is on the camera GUI for both playback and while saving to mass storage.

Figure 6-12: Web-App Review and Save

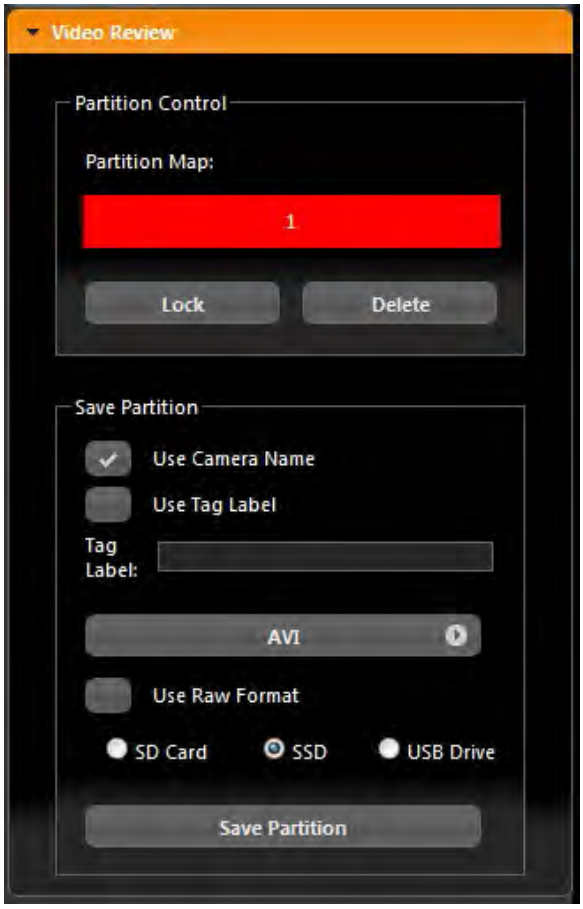


You may jump to the beginning of the clip (|<); to the end (>|) or to the Trigger frame (T). You may also move to any frame by editing the Current Frame box, or by moving the slider beneath it.

The Playback Frame Rate may box may be edited directly or controlled via slider. The Playback Rate governs the speed at which the clip is played back both forward and reverse.

The skip forward >> and reverse << buttons skip at 1/10th the Playback Frame Rate. If you set the Playback Rate at 30, the >> and << buttons will skip forward or back 3 frames; if you set it to 300, they will skip 30, etc.

Figure 6-13: Video Review Tab



Video clips may be saved to mass storage devices attached to or installed in the camera (SD Card, SSD, or USB Drive).

To save a video clip:

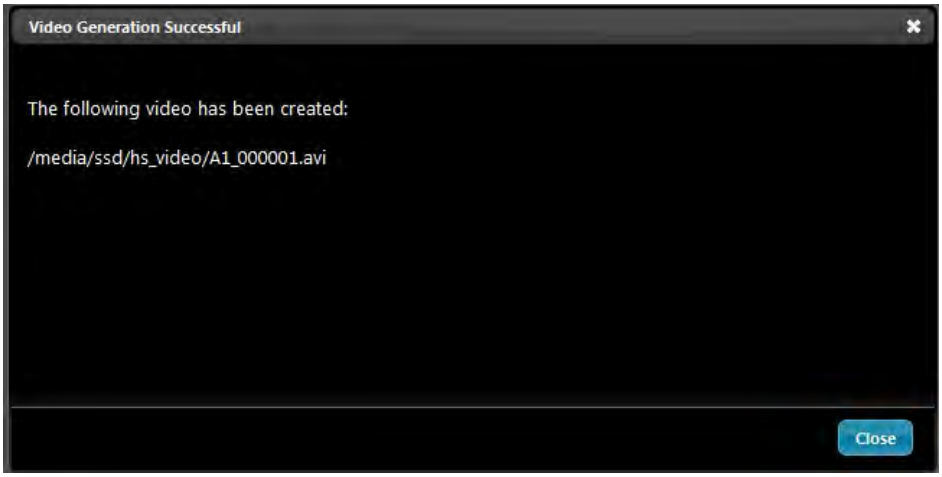
1. Adjust the Clipping Range (edit the boxes or move the sliders) to include the portion of the clip you wish to save.
2. Use the “Use Camera Name” and/or “Use Tag Label” check boxes and the Tag Label edit box to set up the file nam prefix you wish to use.
3. Click on the File Type bar (labeled “AVI” in “Figure 6-13: Video Review Tab”) to select the file type
4. Select or deselect “Use Raw Format.” This check box will be active or grayed depending on the bit depth recorded and the file type selec ed.

Please refer to “4-12 Saving Images to Mass Storage” on page 35 for more details.

5. Select the destination drive using the “SD Card,” “SSD,” and “USB Drive” radio buttons.
6. Click on “Save Partition”

A Progress Bar will appear beneath the image window showing the download status. When finished, an information window as in “Figure 6-14: Download Information Box” will appear.

Figure 6-14: Download Information Box



7 Fas*M*otion Setup

7-1 Install Fas*M*otion Camera Control Software

The Fas*M*otion software install program is copied onto the USB thumb drive that shipped with your TS3 camera.

This software may be used to set up and control TS3 and TS3 cameras. With it you may configure all recording parameters including Session Length, Resolution, Frame Rate, Exposure, Color Balance, Autosave, Trigger point, and Sync options

To install Fas*M*otion on a Windows PC:

Note: At the time of this writing a MAC version of Fas*M*otion is not yet available. Its release is anticipated shortly after the initial release of the product.

1. Run the FasMotion executable on your PC. The file will have the format: FasMotion< version><date>.exe. For exampl FasMotion_1.1.0_2013_0109. exe would be version 1.1.0, dated January 9, 2013. It is recommended that you copy the install fil to the hard drive of your PC for safekeeping.
2. The Windows Account Control will display a message asking if you want to allow the installer to make changes to your computer. Answer “Yes.”
3. The Installer Setup window will appear as shown informing you that the install process has begun. Click on “Next.”

Figure 7-1: FasMotion Installation

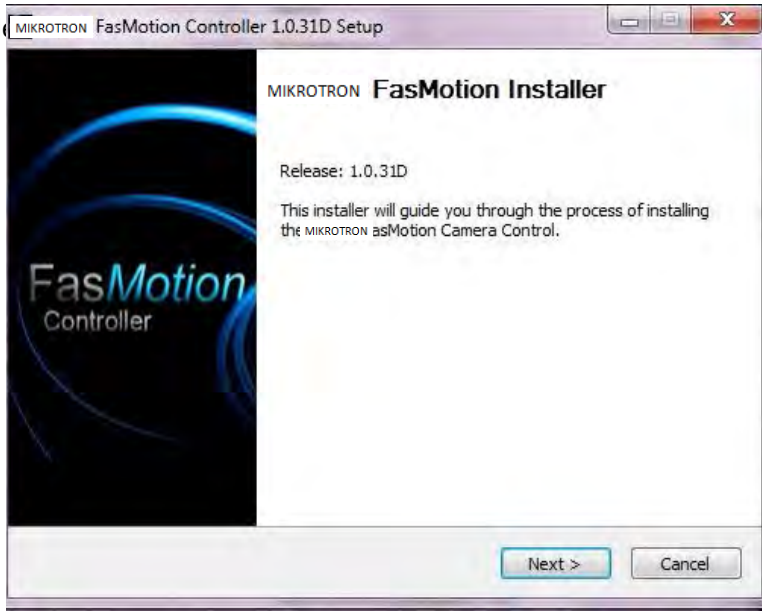
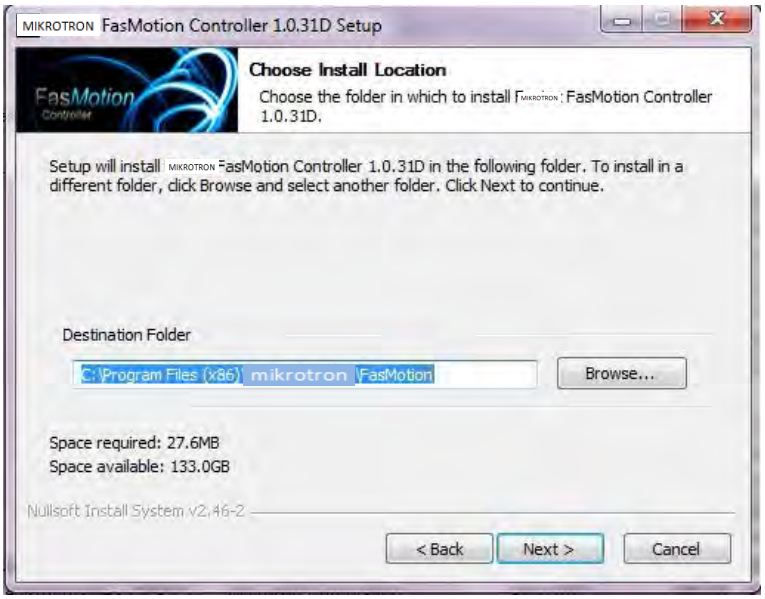
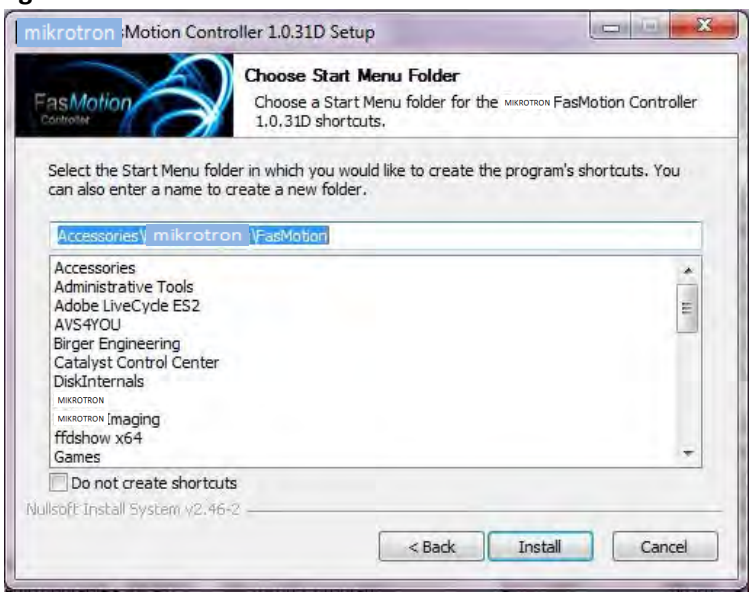


Figure 7-2: FasMotion Install Location


MIKROTRON FasMotion Controller 1.0.31D Setup
Choose Install Location
Choose the folder in which to install MIKROTRON FasMotion Controller 1.0.31D.
Setup will install MIKROTRON FasMotion Controller 1.0.31D in the following folder. To install in a different folder, click Browse and select another folder. Click Next to continue.
Destination Folder
C:\Program Files (x86)\mikrotron\FasMotion
Browse...
Space required: 27.6MB
Space available: 133.0GB
Nullsoft Install System v2.46-2
< Back
Next >
Cancel

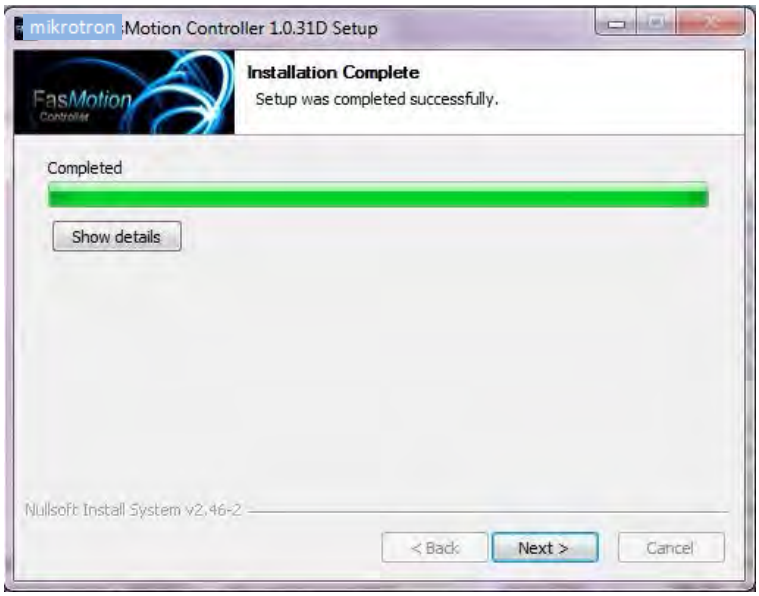
4. The next window allows you to choose a location for the program. Select a locatio and click on “Next.”

Figure 7-3: FasMotion Start Folder



5. The next window gives you the option to creating a short cut for FasMotion in the directory of your choice. Select a directory for a shortcut or click the “Do not create shortcuts” check box. Click on “Install” to continue

Figure 7-4: FasMotion Install Progress



6. FasMotion will now be installed on the PC. A window with a progress bar will appear and inform you when the install is complete.

Figure 7-5: FasMotion Installation Complete

7. The final install window gives you the option to run FasMotion software and a link to the MIKROTRON web page. Click on “Finish” when done to exit the install program.

7-2 Connect the Camera to a Network

TS3 setup may be done via the built-in camera GUI, Fas*M*otion software or the built-in Web-App. This section addresses the use of Fas*M*otion. For details on the Web-App see"6 Using the Web App" on page 42.

The defualt network configuration for the TS3 is DHCP. If a DHCP host is not found on the network, the TS3 will automatically configure itself with a 169.254.xxx.xxx IP address according to Gig-E protocol.

To attach the TS3 to a network:

1. Before connecting to power, connect the TS3 to your network via a switch or router, or directly to your PC using CAT 5E or CAT 6 Ethernet cable.
2. Power up the TS3. See "2-3 Powering Up, Charging, and Power Down" on page 8.
3. Watch the LEDs on the camera's RG-45 connector. When the camera connects to the PC or local network the green LED will begin to blink in a pattern depending on connection speed. (See "Table 3-2: Network LEDs" on page 16.)
4. Start the Fas*M*otion software application
5. Click on the "Find Camera" icon, circled in red on the figure shown here, to open the Find Cameras dialog.
6. Click on the Local Area Connection drop down to get a list of available network interfaces. Select the one you wish to use.

Note: It is possible to use a wireless adapter on your PC, but it is not recommended because of performance issues.

7. Click on the Scan button. Fas*M*otion will list the cameras found available on the selected interface.
8. Select the camera you wish to connect to from the list and click on Connect. Cameras are listed by MAC address. The camera serial number is the last two digits of the MAC address.
9. Make sure the "Stream Video Upon Connection" box is checked if you wish to view live video when the camera connects.

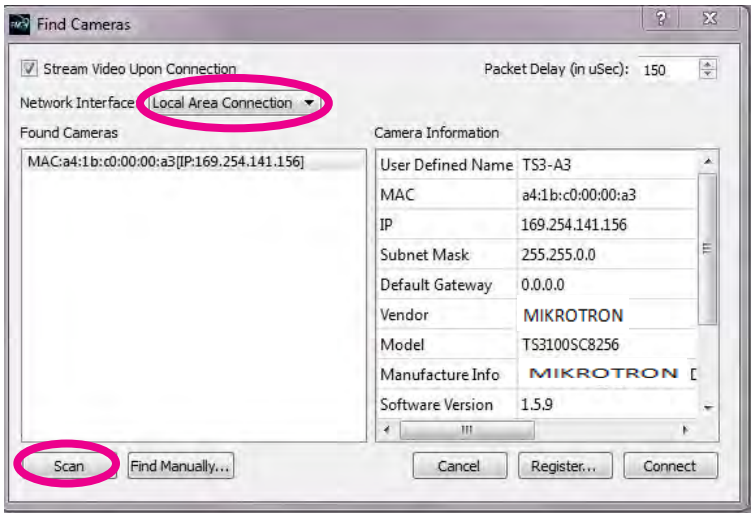
Note: If the camera you are looking for does not appear on the list, you can click on the Find Manually button and enter its IP address.

Table 7-1: TS3 Network LEDs

LEDs on RJ-45 Connector		Camera Networking LED
Green (Connection	Amber (activity	Amber (activity
1 Blink = 10Mb	Blinks for all network activit	Blinks for camera network activity onl
2 Blinks = 100Mb		
3 Blinks =1Gb		

Figure 7-6: FasMotion "Find Camera" Icon

Figure 7-7: FasMotion "Find Cameras" Dialog



7-3 Fas*M*otion Application Window

Figure 7-6 on page 52 shows the application window with no cameras connected. As soon as a camera is connected via Fas*M*otion, two additional docable windows appear. To the left, you see the Control Panel, which has fivee tabs: Storage Settings, record Settings, record Controls, Display Settings and Autosave Setup. To the Right, you see the image window.

The Control Panel may remain docked to the left side of the Fas*M*otion application window or be moved outside of the application window to any location on your desktop. If you use two displays, you may wish to move the Control panel to your extended desktop in order to give yourself a larger image window. The Control Panel detaches by clicking on the gray border at the top in the area where “Control Panel-MAC:...” is printed (circled in red). To return the Control Panel back to the application window, just double-click on that same border.

The Image Window may be detached and moved and/or resized, but it always stays within the bounds of the application window. To detach it, click on the “minimize” button in the upper right corner (circled in red). To restore the window, click on the “maximize” button (in the same location)

The Video Controls pane will appear at the bottom of the Application Window whenever a video is open for review. (See Figure 7-9 on page 54.) This is another detachable pane that may be moved outside the application window by grabbing its top border. Double click on the same border to restore it to its original position

Figure 7-8: Fas*M*otion Application Window

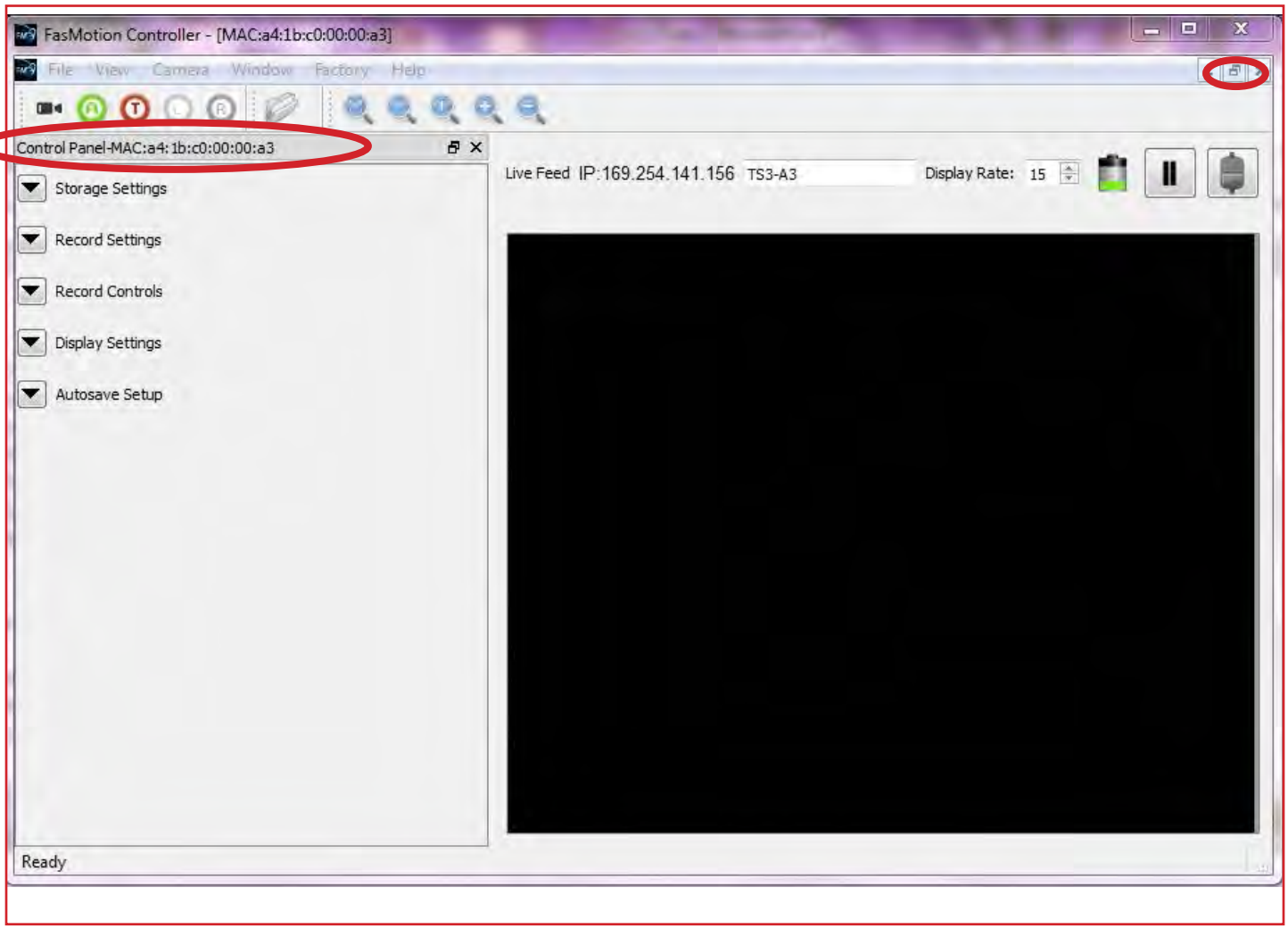
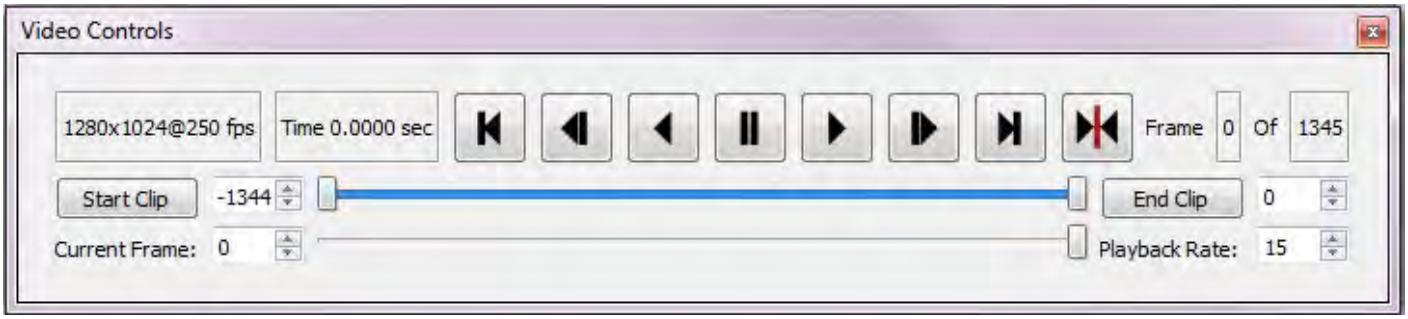


Figure 7-9: Video Control Pane



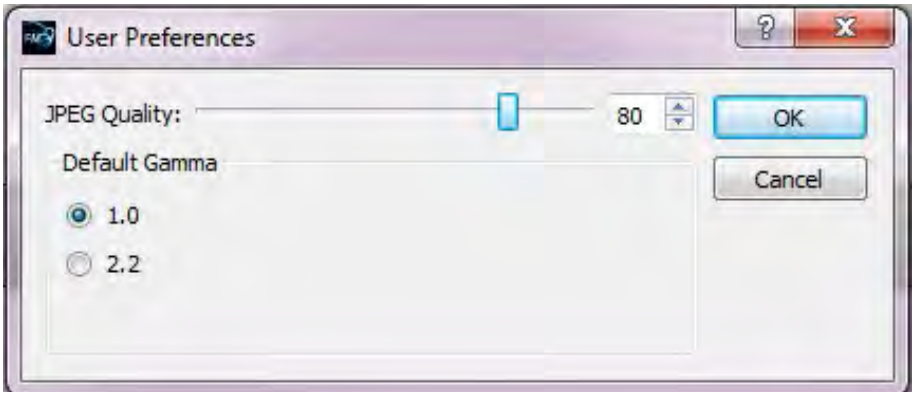
7-4 Controlling the Image Displays

Figure 7-10: View Menu

The View Menu contains zoom controls that are replicated at the top of the application window. These control the size and shape of the Image Window.

Zoom to Window	The full image is sized to completely fill the image window. The image may be distorted as the aspect ratio is lost.
Zoom to Fit (default)	The image expands proportionally and fills the image window without losing its aspect ratio
Zoom 1 to 1	The image is represented pixel for pixel on the display. Depending on the display resolution, the image may only fill part of the image window, or the image may be cut off, in which case sliders will appear so that you may access the entire image.
Zoom In	The image is enlarged greater than 1:1 with the first click, then progressively larger with each additional click. When the image exceeds the size of the window, sliders will appear for ac-cess.
Zoom Out	If you have Zoomed-In on an image, Zoom-Out allows you to back through the zoom setting down to 1:1.

Figure 7-11: User Preferences



Setting Default Gamma in User Preferences:

User Preferences is in the Camera menu.

The Default Gamma setting is used to set the default output Gamma for displayed and saved images.

The default Gamma is 1.0 (linear). Many laptop computer displays have a Gamma of 1.0, while most larger fl t panel LCD monitors have a Gamma of 2.2.

Note that changing the Default Gamma setting does not change the current Gamma of the camera, it sets it reset value. To set the Gamma of the camera to a new default, navigate to the Display Settings tab and select “Reset Light and Color Setting ”

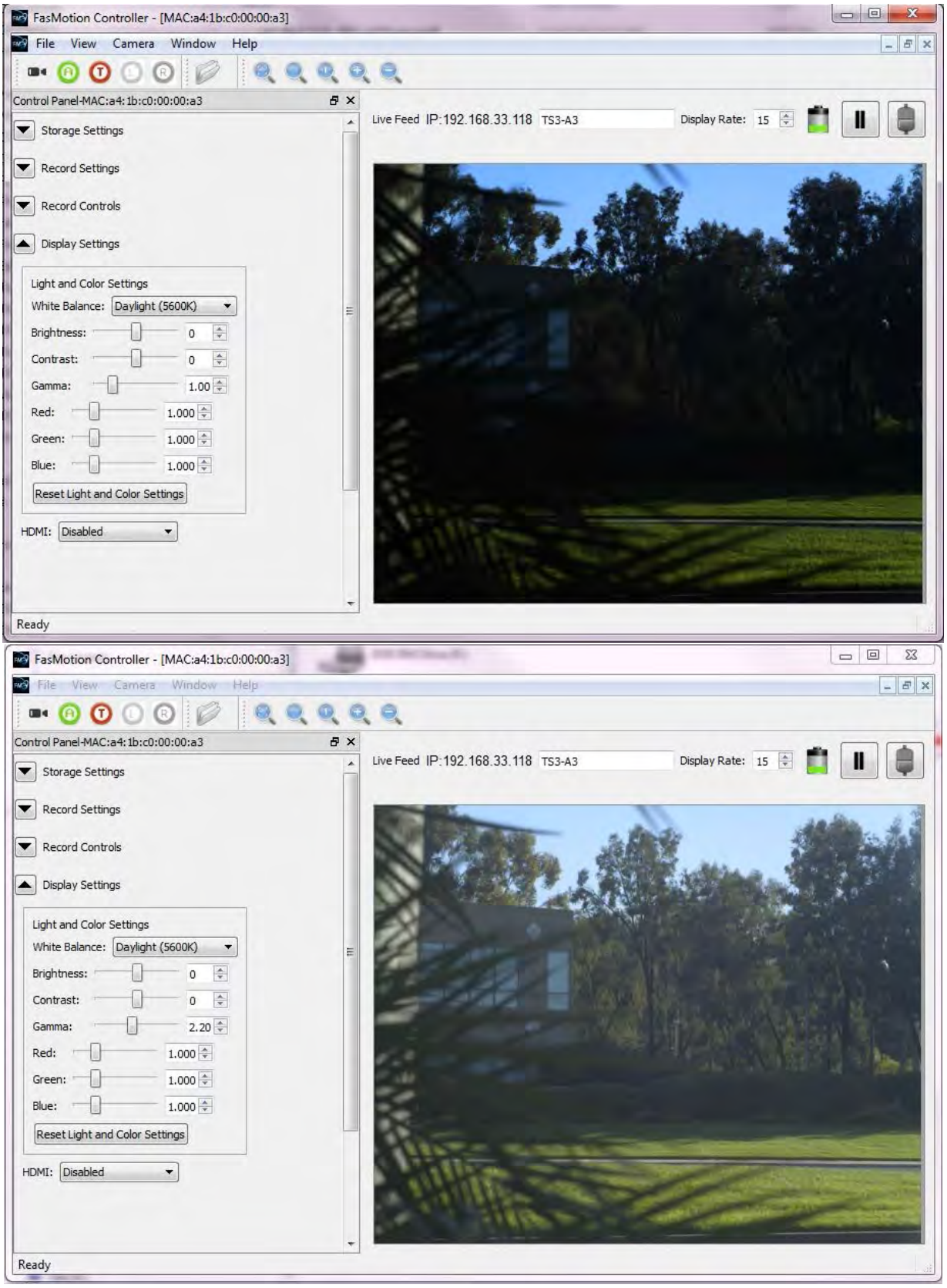
Figure 7-12 on page 55 uses two screen shots of a high-contrast image to demonstrate the difference in appearance between Gamma 1.0 and 2.2. These images were displayed on a monitor with a 2.2 Gamma.

The first image, with Gamma set to 1.0, appears very dark on this display. If the lens is opened or the exposure increased, the dark areas will gain detail, but the brighter areas will saturate.

In the second image, with Gamma set to 2.2 to match the display, the detail in the shadows is evident.

Note: The opposite would happen if the display had a Gamma of 1.0: the first image would have looked good, while the second would have appeared washed out.

Figure 7-12: Gamma Comparison



Display Rate for live images:

The display rate for live images in Fas*M*otion may be adjusted using the spinner at the top of the Image Window. (See Figure 7-12 on page 55.) This number will automatically change according to the performance of the network and the PC.

There is also a pause/play button on the top of the Image Window. This may be used to temporarily start and stop the video stream.

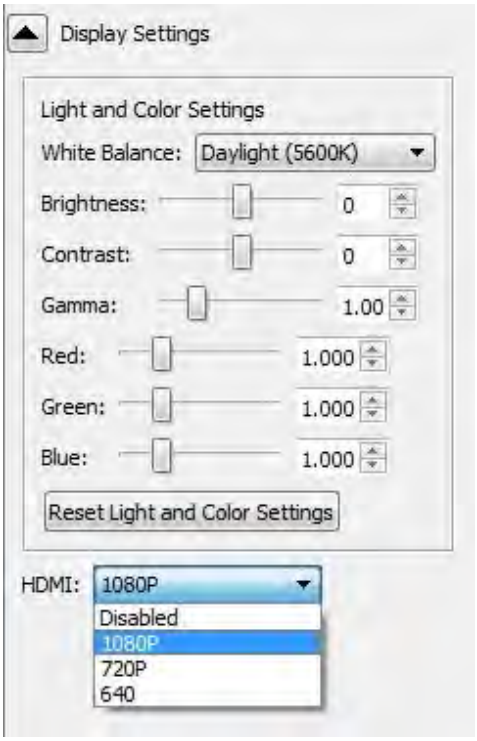
Setting up the HDMI display:

The TS3 has an HDMI output that can be used for displaying both live and recorded images. The HDMI port is located on the side of the camera between the Power and External I/O connectors. See "Figure 1-4: TS3 Side View (Door open)" on page 5.

To enable the HDMI output click on the HDMI button on the Display Settings Tab and select the resolution you wish to use.

Note: The images from the camera will be scaled to fit the HDMI display screen while maintaining aspect ratio. This means that there may be black borders on the sides or top and bottom of images, depending on aspect ratio and best fit

Figure 7-13: HDMI Settings



7-5 Name the Camera

When the TS3 leaves the factory its default name is TS3-xx, "xx" being the camera's serial number. The camera name can be used both for identification on a network and as part of the filename when saving images.

It may be beneficial to rename the camera according to its function, locality, field of view, etc. depending on how the camera is to be deployed.

To change the camera name simply edit the name as it appears in the box above the image window.

There are some limitations in the character set that may be used for the camera name as it must be "legal" both as a filename and network device name. All numbers, and upper- and lower-case numbers may be used. The only punctuation character that may be used is the "-" (not "_").

7-6 Camera Time and Date

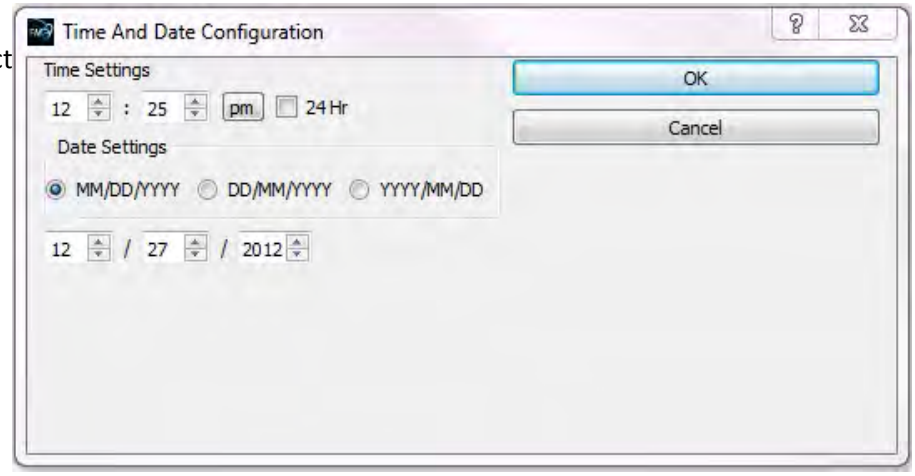
Figure 7-14: Time and Date Configuration

When your TS3 is shipped, the time and date will need to be set to reflect your local time

Access the Time and Date Configuration dialog from the camera menu in Fas*M*otion

Once this is set, a rechargeable battery inside the TS3 will maintain the correct time.

If your TS3 is not powered up for a few weeks, the time and date may need to be reset.



7-7 Connect to a TS3 Outside Fas*M*otion

FasMotion software is the primary user interface for the TS3. It is the most flexible and efficiet way to use the camera. There may be times, however when you may wish to access the TS3 using its built-in Web-Application or through its USB OTG port.

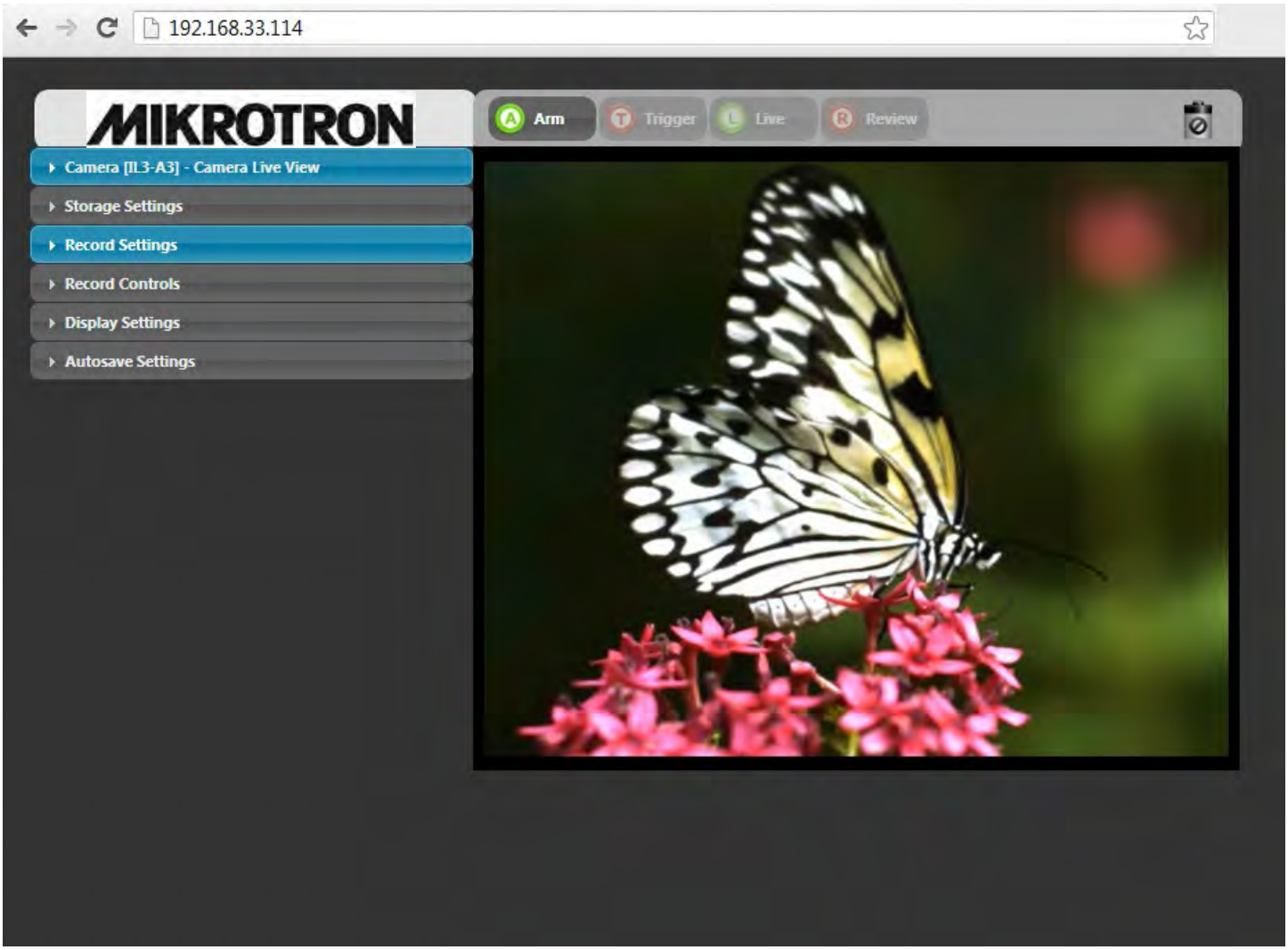
To open the Networked TS3 in a Web browser in the **Web-Application**:

The Web-application works with many web browsers, including Google Chrome, Mozilla Firefox, Apple Safari, and Microsoft Internet Explorer. It works on most PCs, Smartphones, and tablets:

1. Type the camera's IP address or camera name into the browser's Location bar. For example, using the information from "Figure 7-15: Web-Application you would type 192.168.33.114 (IP address) or L3-A3 (the camera name) into the browser's Location bar.
2. A camera control application within the camera does the rest. A control menu will appear in your browser that will give a live camera view and complete control over the camera operation. Details on use of the camera's web browser appear in Chapter 6 of this manual.

Note: The Web-Application is useful for setting up and controlling the camera, but it does not have the display performance (refresh rate) of Fas*M*otion and has no utility for saving video or image files on the host device (PC, Tablet, etc.).

Figure 7-15: Web-Application



You may also wish to open the camera in Windows Explorer in order to copy images from one of the cameras drives to your PC or network.

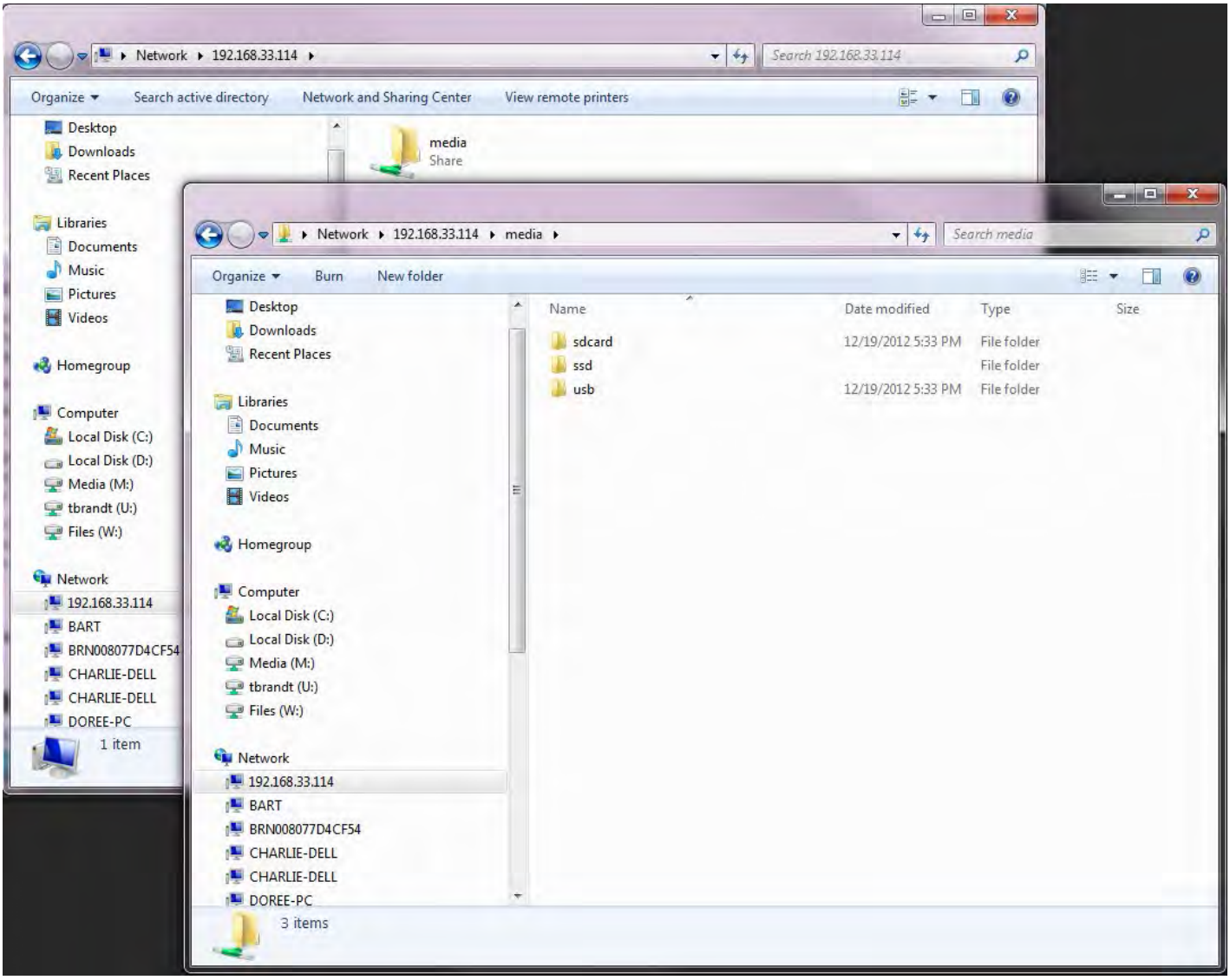
Note: This can be a convenient way to transfer a few files from your camera, but if you wish to transfer large numbers of images or video clips, the Save utility in Fas*M*otion can be many times faster.

To open the Networked TS3 in a Windows Explorer menu:

Type the camera name or IP address in the Location bar, preceded by \\. So, using the same information as in the example below, type in either \\192.168.33.114, or \\TS3-A3.

When the camera is viewed in Explorer, you will see the camera name or IP address under Network. Opening that, you will see a directory called “media,” which contains directories for each mass storage device installed on the camera.

Figure 7-16: Open TS3 Media in Windows Explorer



USB OTG:

Another option for connecting to the TS3 is via the USB OTG port. Please refer back to “Figure 2-3: Mass Storage” in Chapter 2 for details and a comparison of functionality.

7-8 Storage Setup

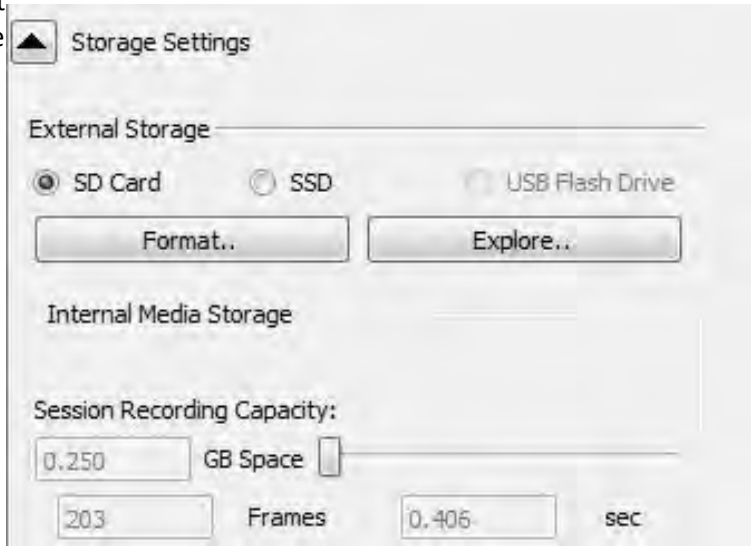
The FasMotion Storage Settings Tab gives the user access and control of the Camera memory and any installed media, including a Solid State Drive (SSD), SD Card, or USB drive.

The TS3 has 4GB, or 8GB of internal high-speed memory used for capturing high-speed imagery (depending on model and option). You can select to use all of this memory when recording, for a smaller amount. Total record time will depend on resolution, frame rate, and bit depth.

Configure Session:

Use the Session Recording Capacity slider to select the amount of memory you wish to use to capture video. This slider has a granularity of 250MB.

Figure 7-17: Fas*M*otion Storage Settings Tab



Use the Format utility in the Storage Setting Tab to format any of the camera media. The SSD, SD Card, and USB drives are all accessible for formatting

Formatting the SSD:

It is recommended that you format the SSD to delete all recordings and completely clean it off. This should be done often to keep performance as high as possible.

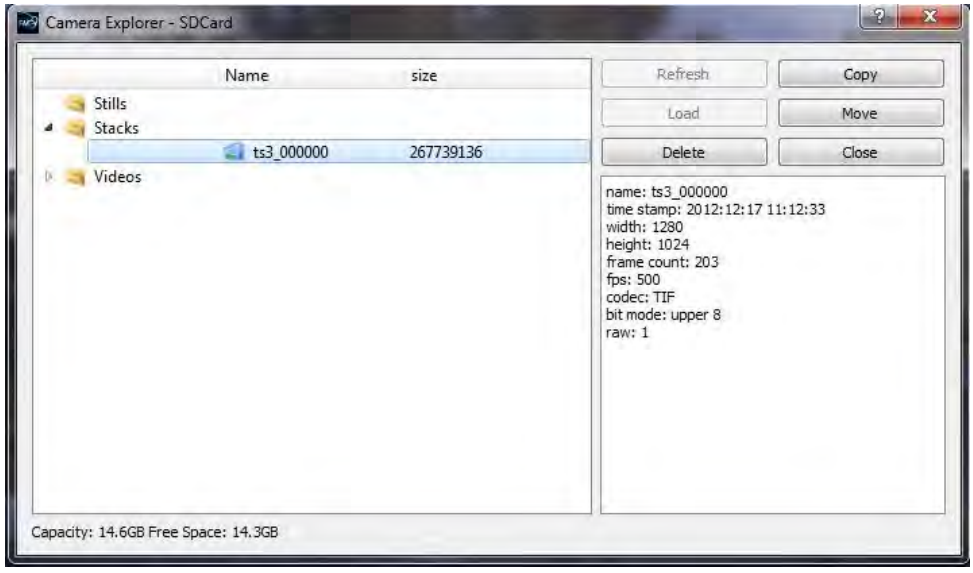
To format the SSD simply select the SSD radio button in the Storage Settings dialog and click on "Format."

Formatting SD Cards and USB drives:

Formatting SD Cards and USB drives is the easiest and most effective way of deleting all recordings. When formatting SD Cards and USB drives, Fas*M*otion will give the option of "performance" or "Compatibility."

The Compatibility format is FAT32, which is recognized by most computers. The Performance format is EXT2, which is a Linux format and may require a 3rd-party driver for application (such as DiskIternals Linux Reader) on your MAC or PC. EXT2 will improve file Save times to the SD Card and USB. The improvement is only about 10% very large images such as full-resolution TIFF and BMP images. The greatest improvement (as much as 6x) is seen when saving large numbers of very small files, such as saving thousands of low-resolution JPEGs.

Figure 7-18: Fas*M*otion Camera Explorer



Exploring Camera Media:

Open the FasMotion Camera Explore dialog by selecting the radio button for the SD Card, SSD, or USB and clicking on the Explore button.

Navigate to the Still, Stack or Video of interest.

You will notice that the information about the clip or still will be displayed, including the time stamp, resolution, frame count, frame rate, and file format.

Any selected still or clip may be copied, moved or deleted.

CAP files, which are proprietary MIKROTRON raw image files, can be loaded back into the camera. When Cap files are loaded back into the camera, the camera may be operated in Review mode, just as when the imagery was originally taken. This will allow you to Save it in any format and to any camera or PC media. See ?????

7-9 Configurations

TS3 Configurations, which include all camera settings (resolution, frame rate, session length, exposure, etc.), can be Saved, Reloaded, or Reset to factory defaults.

To Save the Current Configuration:

Click on Save Config... in the Camera Menu. This will open an Explore window. You will be able to give it a name and save it as a .cfg file in the older of your choosing.

To Load a Saved Configuration:

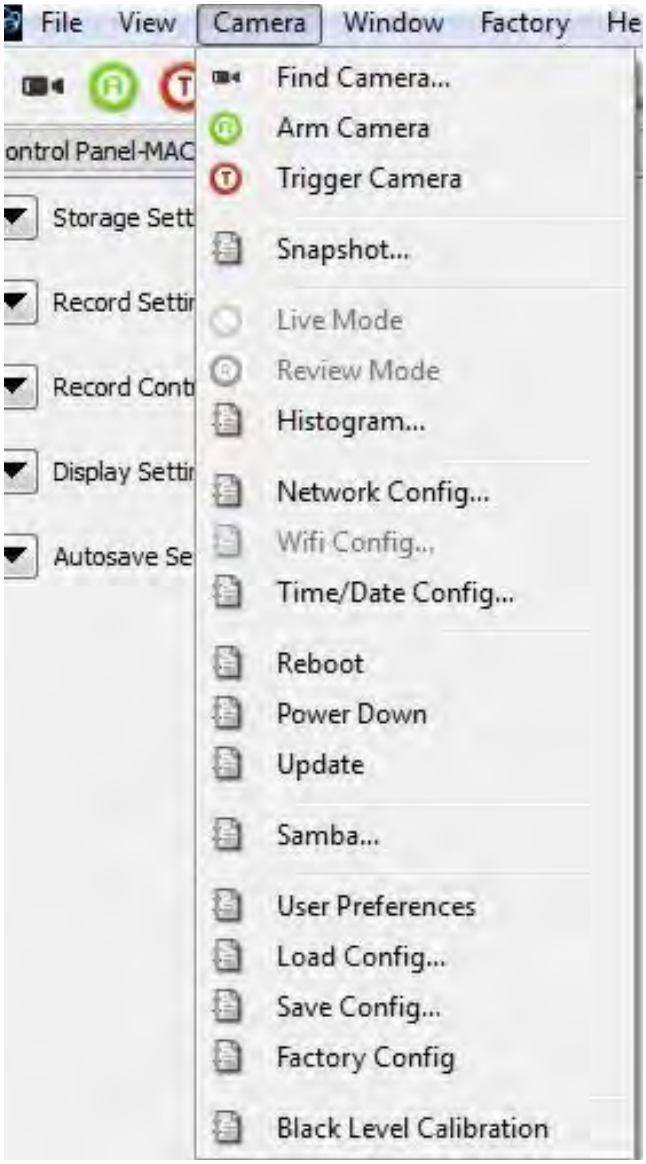
Click on Load Config... in the Came a Menu. This will open an Explore window, which will allow you to navigate to the folder where you saved .cfg files and select the Configuration you would like to load.

To Load the Factory Configuration:

Click on Factory Config in the Camera Menu. This will load the factory default settings for the camera.

Note: This is not a routine operation as it rewrites your camera configuration. Always power cycle the camera after loading Factory Configs

Figure 7-19: Fas*M*otion Camera Menu



7-10 Reboot and Power Down

The camera may be Powered Down or Rebooted from the Camera Menu.

If you power the camera down it will turn off completely. To turn it back on, you will need to re-apply power by removing and restoring the power connector, or by pressing the power button on the top of the camera. (See “Figure 1-1: TS3 Back View” on page 3.)

If you Reboot the camera, it will do a “warm boot.” That is, it will disconnect from FasMotion, clear its memory, and restart its Operating system. Some of the electronics and logic will not be reset during a warm boot.

Note: Both Power Down and Reboot will erase any imagery in the cameras High-Speed internal memory, but it will not disturb any image data already saved to SSD, SD Card, or USB drives.

After a Reboot or Power Down, you will need to re-connect the camera to Fas*M*otion by returning to the “Find Cameras” dialog and scanning for the camera after it boots up. See “7-2 Connect the Camera to a Network” on page 52.

7-11 Camera Information

Camera information is located in the “Find Cameras” window.

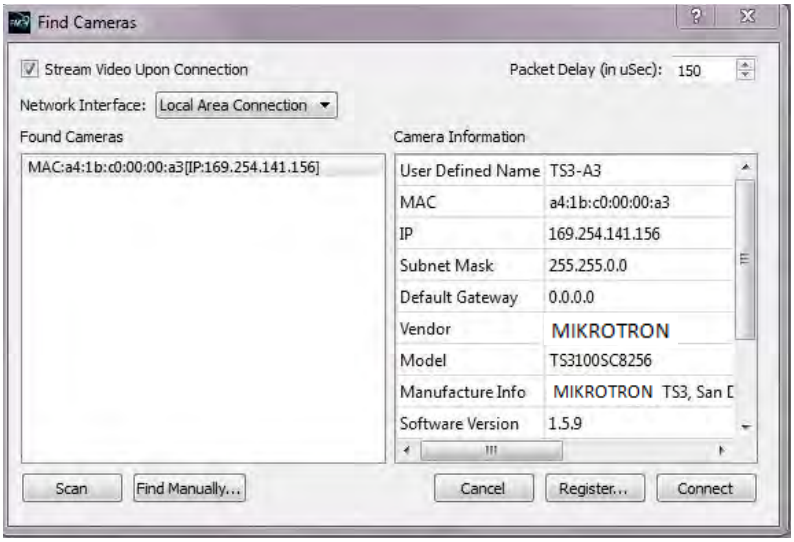
To open the Find Cameras window, click on the Find Cameras icon in FasMotion. (See “7-2 Connect the Camera to a Network” on page 52.)

The information fields will populate as soon as you select a camera from the Found Cameras list.

Information Included

- MAC address
- IP address
- Subnet Mask
- Default Gateway
- Vendor
- Model #
- Manufacture Info (location
- Software Version
- GigE Protocol Version
- Bootloader Version
- FPGA Version
- Sensor Version

Figure 7-20: Camera Information



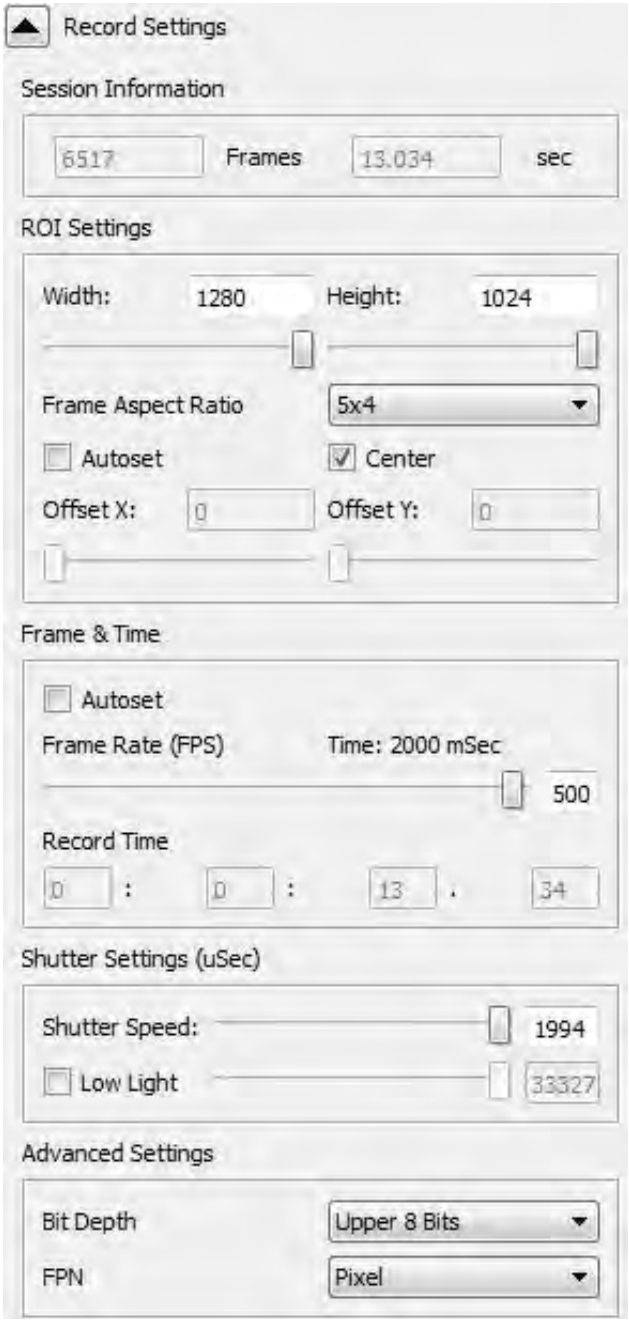
8 Recording with Fas*M*otion

8-1 Setting Frame Rate and Resolution

Record Settings are interactive:

- The Resolution you choose will define the maximum Frame Rate and number of frames that can be captured.
- The Frame Rate will define maximum Shutter Speed (exposure time in μsec).
- The Frame Rate and number of Frames captured defines the duration of the recording (time in seconds).
- If you select Autoset in either Frame Rate or Resolution, that parameter will be selected automatically to its maximum allowable value, dependant on the other current settin

Figure 8-1: Record Settings Tab



To set the **Resolution** of the TS3:

1. Select the Aspect Ratio you wish to use: choices are Custom, 5:4, 4:3, and 16:9.
2. Adjust the image Width (in pixels) you wish to use. This can be done either by editing the number in the Width edit box, or by moving the slider.

Resolutions can be refined to any even-numbered pair from 24 x 12 to 1280 x 1024.

Whenever any slider has focus, it turns blue. It may be then controlled by dragging it with the mouse or using the keyboard arrow keys. Often the best way to do this is by dragging it with the mouse until it is close o the value you want, then using the arrow keys to “zero in” on the exact value.

To set the Frame Rate of the TS3:

Either edit the number in the Frame Rate edit box, or move the Frame Rate slider to the desired position using the mouse and arrow keys.

Offset Control:

Most of the time, to make use of the best resolving properties of your lens, you will want to center the image at the optical center, which corresponds to the center of the sensor. In this case you would make sure that the “Center” check box is checked.

It is also possible, that you will wish to shift your ROI (Region of Interest) without moving the camera.

Lets say, for example, that you have captured images at 1024 x 1024 @ 500fps and are now interested at capturing a 512 x 512 portion of the scene, lets say the bottom right hand quarter @ 2000fps.

In this case, you would wish to add 512 to both the X and Y offset. For a 1024 x 1024 centered image the offsets will be 128 and 0. The resultant offsets for a 512 x 512 image (lower right quadrant) would be 740 and 512.

8-2 Setting Shutter Speed

The Shutter Speed is expressed in microseconds of exposure time.

Minimum Exposure:

Minimum exposure is 2μsec (regardless of frame rate)

Maximum Exposure:

The maximum exposure time is dependant on the frame rate. It is always

$$(1/\text{Frame Rate}) - 6\mu\text{sec}$$

For example, at 500 fps, the maximum exposure is:

(1/500 sec) -6μsec = 2000μsec -6μsec = 1994μsec

For those accustomed to using shutter angle, to convert that to degrees:

$$(\text{Exposure (in } \mu\text{sec)} / \text{Frame Time}) \text{ X } 360^{o}$$

For example, at 500fps, an exposure time of 25 μsec is:

(250μsec / 1/500 sec) X 360^{o} = (250 / 2000) X 360^{o} = 45^{o}

Setting the Shutter Speed:

Shutter Speed is set using the slider or edit box in the "Shutter Settings" section of the Record Settings Tab. (See "Figure 8-2: Shu er Setting .)

Low Light Mode:

In some special circumstances, the light available for setting up the TS3 for a high-speed event is not as bright as what will be used for event itself. You may, for example be using some lights that can only be switched on for a short time and are not available for camera set up.

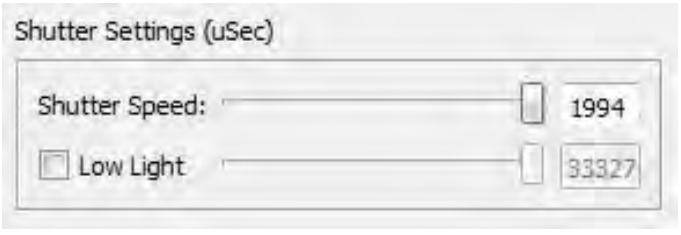
The exposure for Low Light Mode is much longer than would be possible for a high frame rate. The default shutter speed for Low Light mode is 33.327ms, which is the "1X" shutter speed for 30 FPS. The shutter speed for Low Light may be adjusted via Fas***M***otion by checking the Low Light box and moving the slider or editing the Low Light edit box.

To enter Low Light Mode:

Note: Be careful when using the Low Light feature! **It is very easy to forget that it is on!** Remember to set your exposure for the light that will be present during the image capture.

1. Set the Shutter Speed just as you need it for the high speed event.
2. Click on the Low Light check box. A check mark will appear in the box. The edit box and the slider will become active.
3. Adjust the slider or edit the
4. Press the Arm Button.

Figure 8-2: Shutter Settings



The camera will begin recording. You will notice that the image is darker now than in Live Mode.

5. Press Arm again to quit recording. (Click "OK" on the Warning message to Cancel.)

8-3 Setting Bit Depth

The TS3 can record and save 10-bit or 8-bit data. The advantage of recording 10-bit data is that it gives more flexibility in post-processing the imagery. The disadvantage is that it takes more memory to record or save 10-bit data. When recording, you will get about 25% fewer files, and 25% less recording time.

When saving 10-bit data (to a mass storage device) in TIFF (RAW) format, the actual file type is a 16-bit file, so it is substantially la ger than an 8-bit mono file. The 10-bit (R W) color image, however is not colorized--it is a RAW Bayer image (not “colorized,” which would make it about 3x as large), so it is about 2/3 the size of the 24-bit color file (8 bits per each of 3 olor channels).

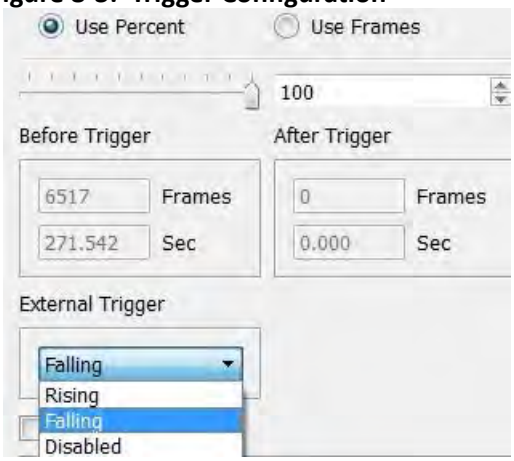
To choose the recording bit depth:

1. Navigate to the Record Menu.
2. Select Bit Depth.
3. Select 8-low, 8-mid, 8-high, or 10-bit. If any of the 8-bit mappings are chosen, the live image will immediately reflect th t change. If 10-bit is chosen, the displayed live image will default to 8-high.

If Bit Depth is set to 10 in the Record Menu, a bit depth selection will appear in the The Display Menu. The choices here are 8-low, 8-mid, and 8-high. This selects the 8-bits used for the display and for saving to media.

8-4 Configuring the Trigger

Figure 8-3: Trigger Configuration



The TS3 uses a fixed, selectable circular buffer to record into. The session length is determined by the user (see “7-8 Storage Setup” on page 59). This section explains how to set the trigger position within the buffer. For an explanation on how the circular buffer works and how to decide on the proper trigger position see “Application Note 3: Trigger Position and the Circular Buffer” on page 97.

To Set the **Trigger Position** in the TS3:

1. Open the Record Settings Tab.
2. Select either the “Use Percent” or “Use Frames” radio button. The slider and edit box represent the session buffer, which is the camera memory you will be recording into. The trigger position, expressed either in % or frames.
3. Set the position by moving the slider or typing into the edit box or using the spinner buttons.

Enabling the External Trigger

There are times when you wish to activate the trigger electrically, either to sync the trigger with other cameras or signals, or to maintain greater precision than can be expected through the software trigger in Fas*M*otion

1. Open the Record Settings Tab.
2. Click on the pull-down in the External Trigger box to expose the choices, which are: Rising, Falling, or Disabled.
3. Choose “Rising” for rising signals or a switch opening and “Falling” for a falling signal or switch closure.

Please refer to “Appendix D: Power and I/O Connections” on page 82 for connection information and warnings.

8-5 Black Level Calibration

Black level calibration does two things:

1. It sets the black level of the camera to ensure that, in the absence of all light, there is no offset or clipping (the “blackest” pixel will have a value of 0).
2. Dark frame data is saved for correcting Fixed Pattern Noise (FPN).

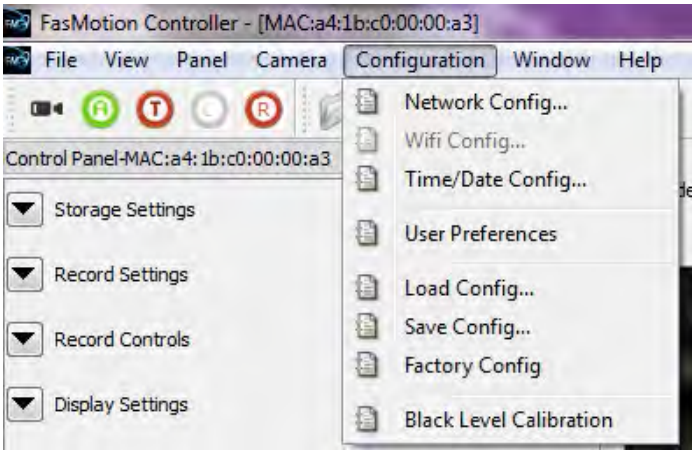
NOTE: Fixed Pattern Noise exists on every image sensor.

Calibrate Black Level:

The general rule is to do a Black Level Calibration if ever you believe the image looks noisy with Pixel FPN turned on. To be assured that you are getting the best possible images, perform a calibration

- When you first boot the camera up.
- If you change Shutter Speed, Frame Rate, Resolution, or Offset.

Figure 8-4: Configuration menu: Black Level Calibration



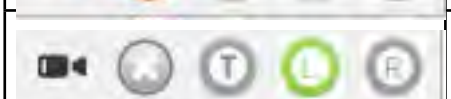
To Calibrate the Camera

1. Set the camera to Live.
2. Shut out all light to the sensor: close the f-stop down all the way and put a lens cap on it or cover it securely.
3. From the Configuration menu, choose Black Level Calibration
4. In the Advanced Settings section of the record Settings Tab (see Figure 8-1 on page 62) you will see an FPN selection dropdown menu. The items include Disabled Column, or Pixel. Click on that button and select the FPN setting ou wish to use, based on the following:

- **Pixel FPN** is a per-pixel image correction that is done in the TS3’s image processor engine. It provides the cleanest images available. This is the setting that is most highly recommended.
- **Column FPN** is an image correction done on the TS3’s sensor. It does not do as good a job cleaning up the images as Pixel FPN.
- **FPN Off** means that there is no noise correction being used.

8-6 Record: Arm and Trigger

Table 8-1: Sample Frame Rates and Resolutions

	Live Mode	A (Arm) and T (Trigger) buttons active: Camera in Live mode, waiting to Arm
	Recording: Armed	A (Arm) and T (Trigger) buttons active: Camera is Armed, waiting for the trigger
	Recording: Triggered	No buttons active: Camera has been triggered and is continuing to record
	Review Mode	L (Go to Live)button active: Camera has been armed and triggered, in Review
	Live Images in Buffer	A (Arm), T (Trigger) and R (Review) buttons active: Camera in Live mode, has a recording in the buffer

Lights Camera Action!

- Black Level Calibration has been done
- The scene is framed and focused
- The Resolution and Frame rate are set
- The Shutter Speed is set
- The Bit Depth is set
- The Trigger Point and Trigger Type is set

Take a Still JPEG

Still JPEG Image. It is optional, but recommended, to take a reference still of the scene:

With the TS3 in Live Mode (not Recording or Reviewing a recording) either click on the Trigger Button or click on “Snapshot...” in the Camera menu.

A dialog box will appear asking where to store the image. Select the storage media you wish to use. (The image will be saved in <storage device>/dcim/100fastc.)

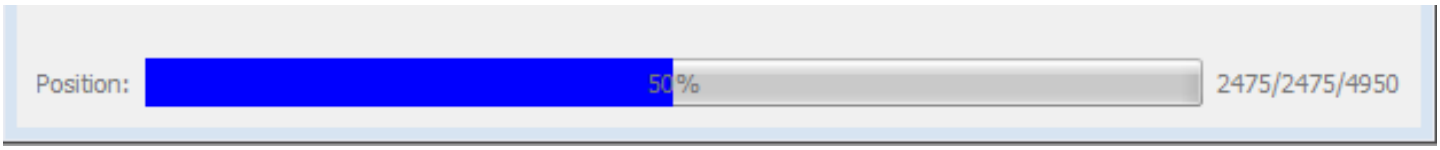
To begin Recording, Click the Arm Button:

The Arm Button will turn from green to brown (see “Table 8-2: Camera Control Buttons”) and the camera begins recording into its circular buffer (see “Application note 3: Trigger Position and the Circular Buffer” on page 97 for an explanation of the circular buffer). The Camera LED will change from Green (LIve) to slowly flashing Amber. It will record for an indefinite period of time until it sets a Trigger. (See “8-4 Configuring the Trigger” on page 64.)

If the Arm Button is pressed a second time , the Recording will abort. The button and the LED will return to green.

The recording state is indicated by a progress bar at the bottom of the image window. Numbers to the right of the progress bar represent the number of recorded / post-trigger / total frames.

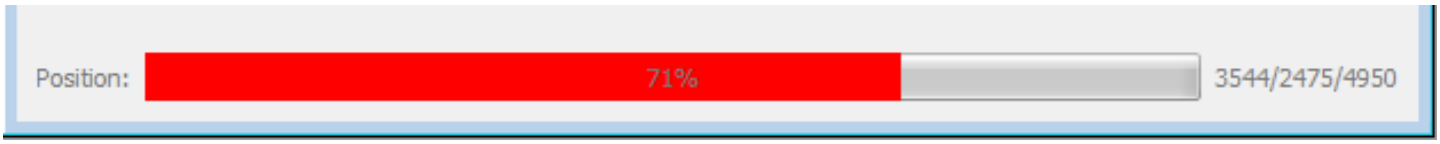
Figure 8-5: Record Progress Bar: Armed



When all of the pre-trigger frames have been recorded, the progress bar stops and flashes blue/ red.

Note: If the TS3 is triggered before the pre-trigger portion of the buffer is full, it will immediately cease taking pre-trigger frames, record frame “0” and progress to the post-trigger portion of th recording. When complete, the recording will have contiguous frames, with the full complement of post -trigger frames, but fewer pre-trigger frames. (See “8-4 Configuring the Trigger” on page 64.)

Figure 8-6: Record Progress Bar: Triggered

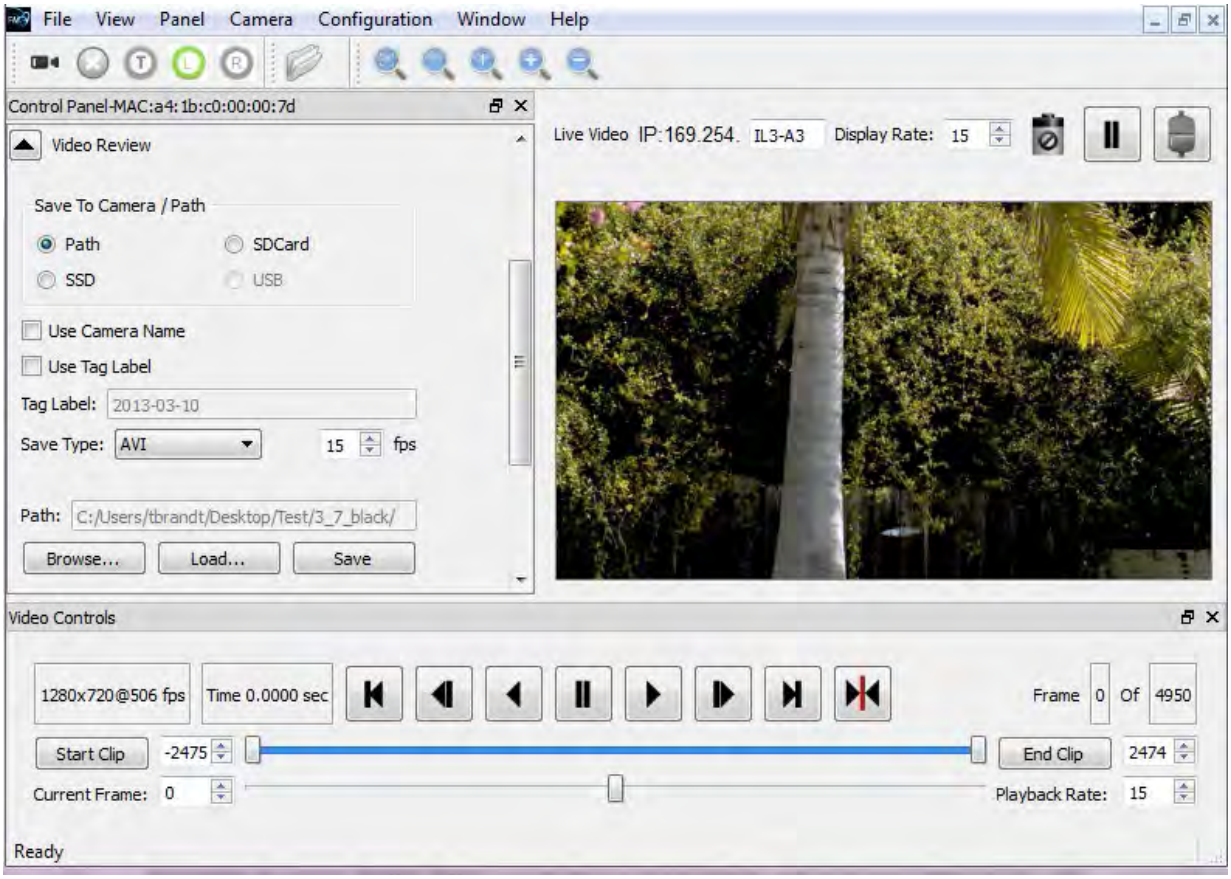


To end Recording, Click the Trigger Button:

Click on the Trigger button, (see “Table 8-2: Camera Control Buttons” on page 69) or send an electrical trigger signal (see “Appendix D: Power and I/O Connections).

When triggered, the TS3 will capture frame “0” and the post-trigger frames. When the recording is complete, the progress bar will disappear, the Video Review Tab will open exposing the Save dialog, and the Video Control (Playback) pane will open.

Figure 8-7: Video Review tab and Video Controls



8-7 Autosave

The TS3 may be used to capture many consecutive events. Using Autosave, this can be done unattended, that is, the camera may be left at a location or automatically, Trigger, Save captured imagery, and then re-Arm itself indefinitely-constrained only by the mass storage space available.

Consider that a TS3 with an optional 256GB SSD installed, depending on the resolution and download file format, could record and save hundreds or even thousands of events in a completely unattended mode! Even if using an SDHC, many events may be captured.

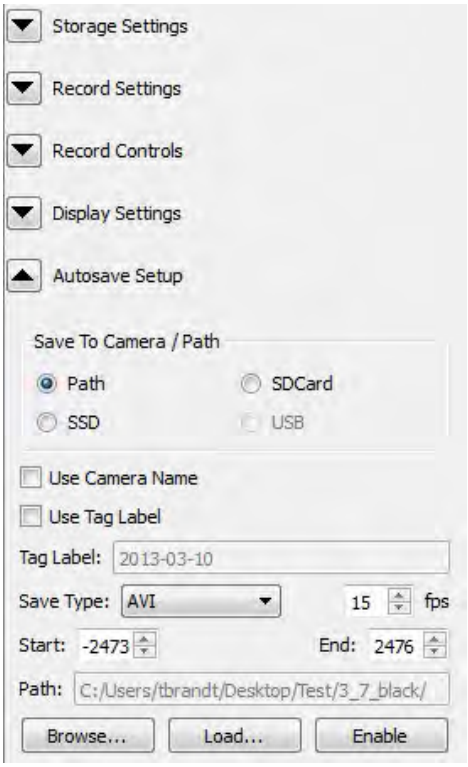
Advantages of using Autosave:

- Autosave is a good choice for **multiple rapid events**. When you are planning to save every capture and review later, the fastest way to get the job done is to use Autosave.
- Autosave is also useful for **production environments** or in any scenario where it is used for multiple consecutive tests without any setup changes. Here it is preferred because it limits human intervention, thereby limiting both human effort and the possibility of human error.
- In an **unattended event,** especially in a **remote location** or when there is no easy access to the camera, Autosave is recommended because it is the quickest way to secure the image data. Saving the data to nonvolatile memo y can be important if there is a possibility of power loss.

- Use Autosave for any unattended event where there is a possibility of a spurious trigger where the camera might trigger prematurely. If Autosave is used, there is a good chance that the camera will have returned back to Record mode in time to capture the planned event.

To set up **Autosave**:

Figure 8-8: Autosave Setup Dialog



The Autosave Setup tab is always available in Live mode.

1. Select a target drive using the “Save to Camera / Path radio buttons. If you select “Path” the target drive and folder will be a folder on a drive accessible by the PC. The Path to that folder is shown at the bottom of the dialog. If you would like to change the path, click on the “Browse...” button and navigate to and/or create the folder you wish to save to.
2. Select a file type from the “Save Type:” pull-down list. File type choices may change depending on the target drive. If you wish to save CAP files, you must save to the SSD. If you wish to save AVI files, you must save to a location other than SSD. See “Application Note 6: Choosing an Image File Format” on page 109.
3. Set start and end points for your saved clips (only if you wish to save less than the full session).
4. Click on “Enable” to enable Autosave. If there are images presently in the buffer you will get a message asking if you would like to save that image data and re-arm the camera. If there are no images in the buffer you will just go back to Live mode until the amera is Armed.
5. Arm and trigger the camera. Autosave will continue re-arming itself, capturing images and downloading them until the target drive runs out of space. At this time it will progress to Review mode so the user download manually to a different drive or clear space.

Note: There is a “Load” button on the Autosave dialog box. This button is a shortcut to the SSD Partition Capture folder that allows you to select a CAP file o load into the camera.

8-8 Reviewing Captured Imagery: Playback

Once the recording is complete, if Autosave is not enabled, the TS3 will open the recording in Review Mode. There are several things to do in Review:

- **Play** the video--play it forward, backward, frame by frame, adjust the cut-in and cut-out points (find the interesting portion of the clip), etc.
- **Adjust** the image brightness, contrast, gamma, bit depth, color, etc. (See “8-9 Image Processing” on page 70.)
- **Save** video to a mass storage device. (See “8-11 Saving Images to Mass Storage” on page 73.)
- Load a CAP file from SSD to memory for Review.

Searching for Interesting Parts:

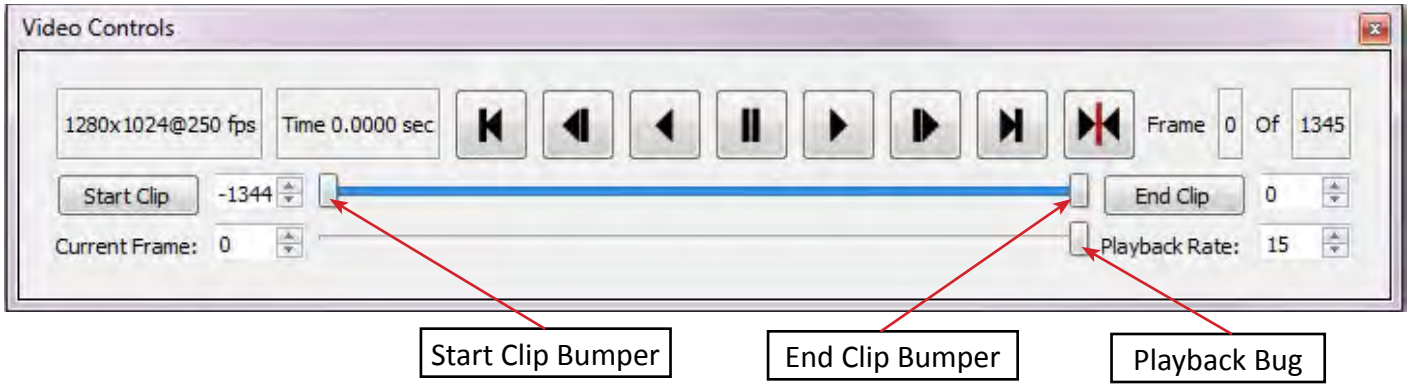
Very often the first thing you will wish to do when reviewing a clip is to “scrub” through it using the playback slider looking for the most interesting moments.

1. Click on the Pause Play button. (Only necessary if you have already clicked on another of the playback buttons.) This will enable all of the playback buttons (they become black). (If any of the buttons become grey (inactive) you will not be able to scrub through the clip.
2. Move the Start Clip bumper all the way to the left (beginning of segment) and the End Clip bumper all the way to the end. (This is the default position when you enter Review.)
3. Click and hold the Playback Bug and move it along the progress bar. This will allow you to move to any point in the video that might be of interest.

Setting the Start Clip and End Clip points:

1. Click on the Pause play button. All buttons should now be active (black).
2. Click and drag the Playback Bug to the frame you wish to be the starting point. You can use the Current Frame edit box and/or spinner, or your PC keyboard <- and -> keys to zero-in on the correct frame.
3. Click on the Start Clip button. The Start Clip Bumper will move to that frame.
4. Move the Playback Bug to the frame you wish to be the ending point (as in #2, above).
5. Click on the End Clip button.

Figure 8-9: Video Controls (Playback)



When playing , the video will start and end between the Start Clip and End Clip bumpers.
The Start and End Clips also define the range of frames that will be Saved. (See “8-11 Saving Images to Mass Storage” on page 73

Table 8-2: Camera Control Buttons

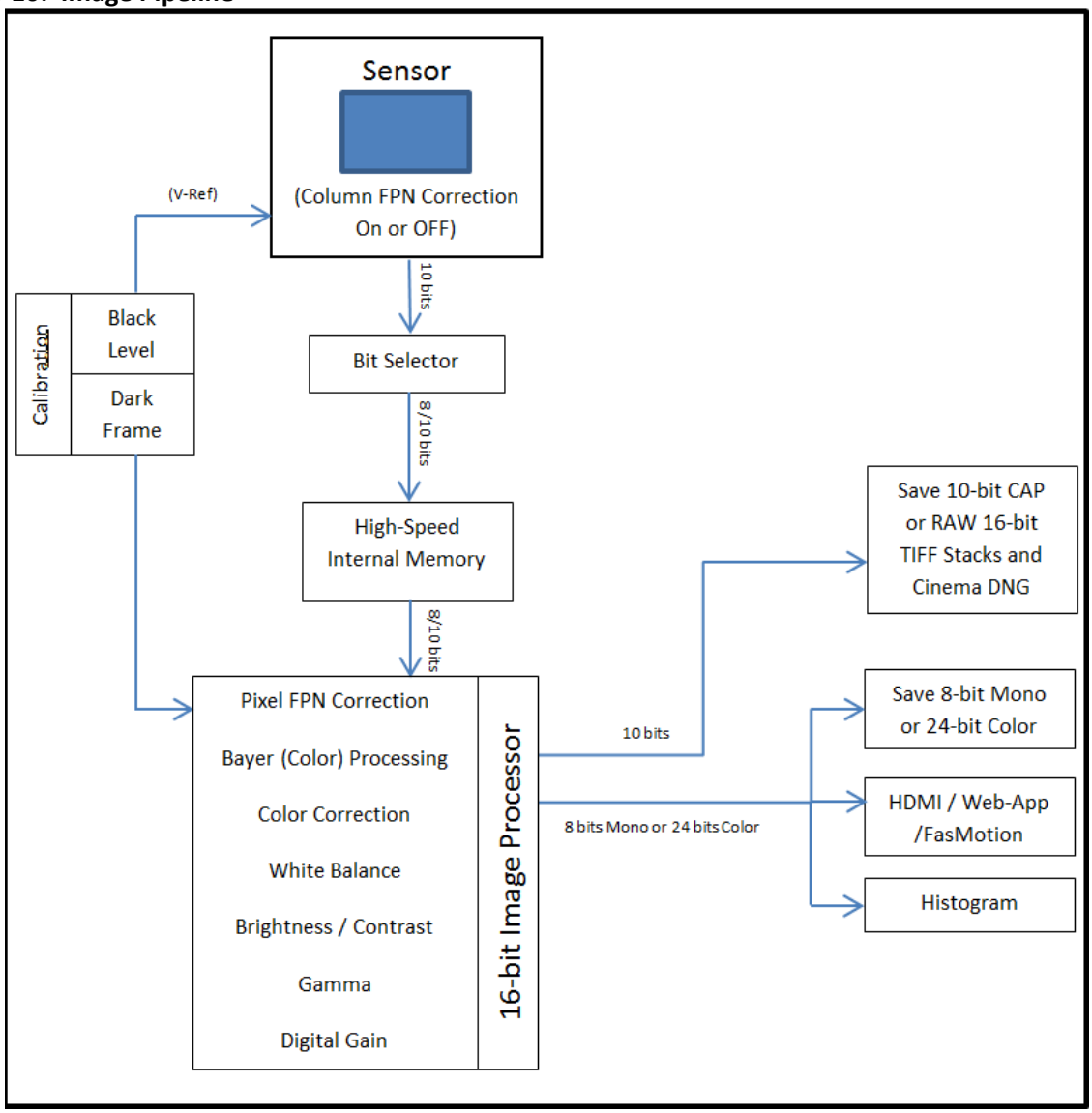
	Go to beginning of clip--goes to Cut-In point. Click a second time and it goes to the very beginning of the video.
	Move one frame backward. When highlighted, hold OK button on D-Pad to skip backward.
	Play backward. Use up and down buttons on D-Pad to adjust speed.
	Pause play.
	Play forward. Use up and down buttons on D-Pad to adjust speed.
	Move one frame forward. When highlighted, hold OK button on D-Pad to skip forward.
	Move to end of clip--goes to Cut-Out point. Click a second time to go to the end of the video.
	Jump to Trigger frame.

8-9 Image Processing

Image Processing Pipeline.

The TS3 image processing begins in the LUPA1300-2 sensor, where on-chip column FPN corrections occur (if enabled) and the Black level is set using data collected during calibration. Pixel data, also collected during calibration is used for Pixel FPN correction (if enabled). (See “8-5 Black Level Calibration” on page 65.) The TS3 does more image processing internally, some of which can be controlled by the operator. To better understand how this works, please refer to “Figure 8-10: Image Pipeline”.

Figure 8-10: Image Pipeline



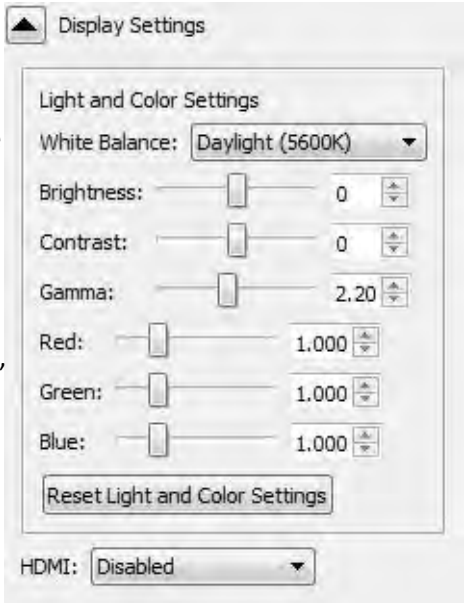
The 10-bit sensor output goes to the Bit Selector, then to internal high-speed memory. This selection is made by the user when bit depth is selected. (See”8-3 Setting Bit Depth” on page 64.)

The path for all images and the input to the histogram is: Sensor, to Bit Selector, to Image Processor, to Display / Histogram. It is always 8-bit Mono or 24-bit Color. Live images pass through from high-speed memory to the image processor immediately. Captured images are saved in high-speed memory until the camera powers down or the images are written over.

- Images in the internal high-speed memory have not yet gone through the image processor. This means that the image processing settings have NO effect on the images in high-speed memory--they only affect the images as they are saved or displayed.
- Images in high-speed memory may be viewed or saved multiple times with different settings

- Live images seen on the display ALWAYS go through the image processor.

Figure 8-11: Display Settings



User Control of Image Processor

- Bayer (Color) processing (color cameras only) is done in order to display a color image. The user may select to save images that have not gone through Bayer colorization by choosing to download a RAW format (See “8-11 Saving Images to Mass Storage”.)
- Color Correction is controlled via “White Balance” in the Display tab. You may choose from several color temperatures: Daylight (5600K), Tungsten (3200K), and Fluorescent (4100K) and Normal setting 1:1 (all channels at nominal gain). There is also a “Custom” setting used to white balance using a grey target and an RGB gain dialog for further manual adjustment. See “8-10 Custom Color Correction.
- Brightness and Contrast are controlled via sliders and spinners. Users select levels from -100 to +100 (default = 0).
- Gamma is also adjusted in this dialog. Levels range from 0.20 to 5.00. Gamma 2.2 is the default as it is the most common display gamma for monitors. For a linear display choose a gamma of 1.00.

Note: Making a selection from this menu only affects the Displayed image and any (non RAW) images saved to mass storage devices. It does not affect the either the 8-bit or 10-bit images as they are recorded into the TS3’s high-speed internal memory. **Adjustments made here may be done before and/or after the imagery is captured.**

Note: All image processing is done using 16-bit math. If 8 bits are recorded, they will be used as the upper 8 bits of the 16-bit calculations by the image processor. The upper 8 bits of the results are then used as an output. Similarly, if 10 bits are recorded, they will be used as the upper 10 bits of the 16-bit calculations. This is true regardless of the output bit depth, thus the lower two bits of the 10 bits recorded are used when computing color corrections and image adjustments, even if you are viewing or downloading 8/24-bit formats.

8-10 Custom Color Correction

When the preset White Balance options, Daylight, Tungsten, and Fluorescent, do not give you the color reproduction you need, there are a couple of other options available:

The Custom item in the Display/White Balance menu allows you to set the color correction via a gray card or neutral gray object.

To use Custom White Balance:

1. Click on the “Custom” button in the White Balance menu. A rectangular reticle will appear in the middle of the image window and a special histogram will appear (See “Figure 8-12: Custom White Balance” on page 72.)
2. Center the reticle (the white box in the center of the image) on a neutral gray object in the field of view. In this instance we are using an 18% gray card, which is the recommended target. Most often the card will only fill a portion of the field of view--it only needs to fill the reticle. It is important that the card, or other neutral gray object is located close to the objects of interest and is exposed to the same light as the objects you are going to image.
3. Adjust the lens aperture so that the histogram shows the pixel values grouped high (to the right

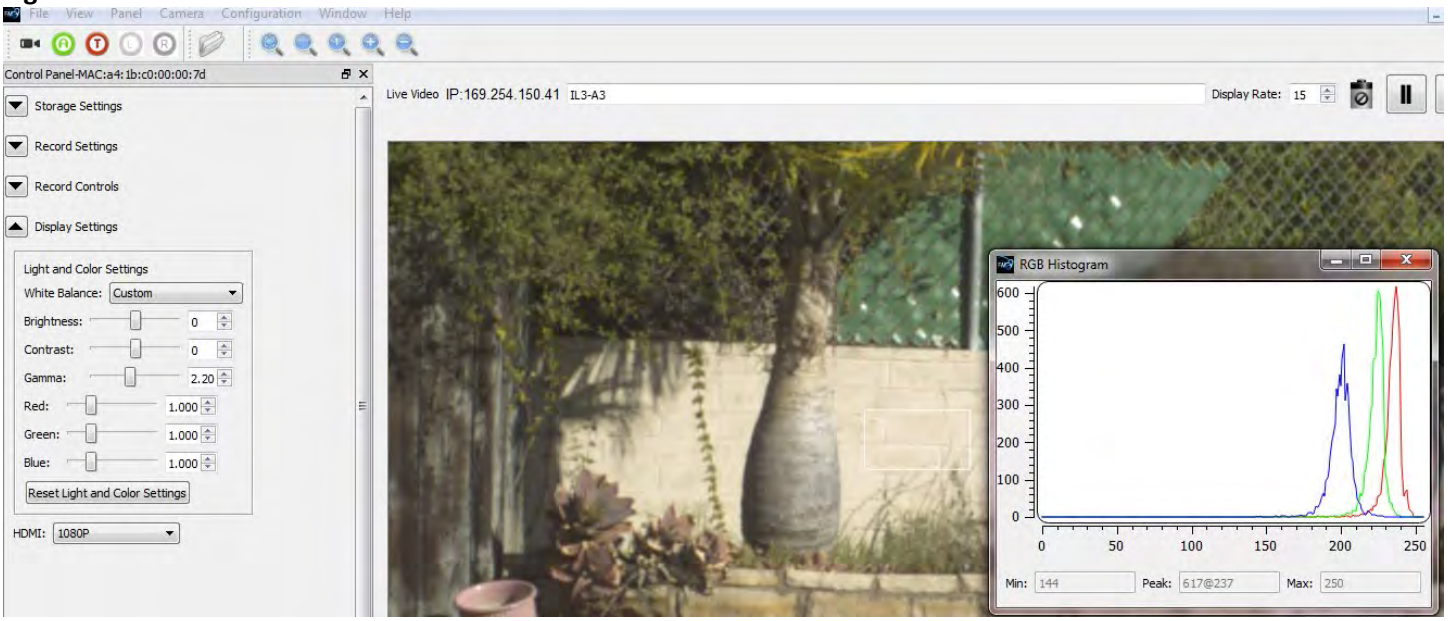
side of the box), but not saturated. It is important that the high pixel value is less than 255. Notice on the example here, that the RGB peaks are not well aligned and that the Blue peak is farthest to the left. This means that the color is skewed slightly towards the yellow, the complement to blue.

Note: The histogram used with Custom White Balance represents only the area of the reticle, not the whole image. For more information regarding TS3 Histograms please refer to “Application Note 1: Histograms” on page 93.

4. Press the Trigger button. You will immediately notice an difference in the color.

Using RGB Gain Controls

Figure 8-12: Custom White Balance



Another option for addressing color correction is via RGB Gains. It is recommended that you use the RGB gains sparingly and as a final “tweak” to make subtle changes to the color. The best use of this is to get the color as close as possible using the White Balance presets or Custom options before adjusting the RGB gains.

To use RGB Gain:

1. Open the Display Settings Tab. You will notice sliders with edit boxes and spinners for Red, Green, and Blue.
2. For any color gain you wish to increase, move the slider to the desired position. Remember to use the D-Pad for fine adjustment.

Note: Remember that in the Bayer pattern, 1/2 of the pixels are green, 1/4 are blue and 1/4 are red. Whenever you change gain values you will be adding some noise to the image. It is best to avoid using any more gain than you need to, and to take special care with the green channel as it represents half of the pixels in the image.

8-11 Saving Images to Mass Storage

Image sequences may be saved as CAP files (proprietary raw format, see “Appendix K: Partition Capture (CAP) File Format” on page 91), as AVI videos, in which one file contains all the frames of the sequence, or TIFF, JPEG, or BMP stacks, which are collections of files, one file per frame of imagery. The file save options changes depending on whether or 8-bit or 10-bit image data has been written to internal high-speed memory:

Table 8-3: File Save Options

10-bits recorded	8-bits recorded
TIFF (8-bit M /24-bit C) or RAW TIFF (16-bit)	TIFF (8-bit M / 24-bit C) or RAW TIFF (8-bit)
DNG (16-bit raw format)	DNG (8-bit Raw format)
BMP (8-bit M /24-bit C)	BMP (8-bit M/ 24-bit C)
AVI (8-bit M /24-bit C)	AVI (8-bit M / 24-bit C)
JPEG (8-bit M /24-bit C)	JPEG (8-bit M / 24-bit C)
CAP (10-bit raw format)	CAP (8-bit Raw format)

Calculating file sizes for TIFF and BMP images is very simple:

Resolution x Bit depth/8 = approximate BMP or TIFF file size in Bytes

(to convert Bytes to KB divide by 1024)

For example a 1280 x 1024 Mono BMP or TIFF is:

1280 x 1024 x 8 / 8 = 1,310,720 bytes = 1,280K

A 1280 x 1024 16-bit RAW TIFF/DNG is:

1280 x 1024 x 16 / 8 = 2,621,440 bytes = 2,560K

CAP files are always the size of the current buffer (session size).

The actual file size of a 1280 x 1024 mono BMP or TIFF is about 1281K (the additional 1K for the file header). The actual size of 16-bit RAW TIFF is 2561K (again add an additional 1K for the header).

Note: The RAW 16-bit TIFF saved from the camera actually has 10 bits of image data. The 16-bit format is used for compatibility reasons.

Calculating file sizes for AVI and JPEG images is much more difficult. The compression is often approximately 10x to 20x, but it can be much greater for images with little content, and it can be much less for very complex images.

RAW images are not colorized, so Mono and Color images are the same size. Colorization increases file size 3x because 8 bits are saved for each of red, green, and blue channels.

To **Save** a recording to a connected mass storage device on the TS3:

1. Make a recording and establish the Start Clip and End Clip points you wish to use (see “8-8 Reviewing Captured Imagery: Playback” on page 68).

Note that the frame numbers initially shown in the dialog box will be the actual start and stop frames for the entire capture *unless* the Start Clip and End Clip bumpers have been moved. If you are not sure what the actual beginning and end frame numbers for the clip are, you can find them on the far left / far right sides of the Clip bar.

1. Select a target drive using the “Save to Camera / Path radio buttons. If you select “Path” the target drive and folder will be a folder on a drive accessible by the PC. The Path to that folder is shown at the bottom of the dialog. If you would like to change the path, click on the “Browse...” button and navigate to and/or create the folder you wish to save to.
2. Select a file type from the “Save Type:” pull-down list. File type choices may change depending on the target drive. If you wish to save CAP files, you must save to the SSD. If you wish to save AVI files, you must save to a location other than SSD. See “Application Note 6: Choosing an Image File Format” on page 109.

- The default file name format for the image stacks is Frame_000000.<TYPE>. If you would like the name to include the camera name, Select Use Name in the dialog. The resulting file name format for the example would become TS3-11_000000.<EXT>.
- If you would like to add a tag to the name, select Tag. The Tag may be edited. Using the Tag in the example, the file name becomes 2011-10-11_000000.<EXT>.
- Both the Name and the Tag may be used, in which case the file name becomes TS3-11_2011-10-11_000000.<TYPE> in the example.
- If AVI files a e saved, the default file name is TS3_000000.AVI. The Use Name and Use Tag options are also valid for AVI files in which case the resulting file names are TS3-11_000000.AVI, or 2011-10-11_000000.AVI, etc. If the file size exceeds the 4GB limit for 32-bit file systems, the TS3 will make a second file for the remainder of the imagery. (MiDAS and other players will play the video as one.)
- If CAP files are saved, they will not use either the camera name or the tag. CAP files are saved only to the SSD. They must be loaded back into high-speed memory in the camera to be reviewed, then converted into a downloadable file format.

Note: CAP files load back into memory much faster than they are saved, taking approximately 45 seconds for a full 8GB load and proportionately shorter times for smaller ones.

When the TS3 saves imagery to mass storage it creates the following:

- DCIM. This is an industry standard directory name for Digital Camera Images.
- 100fastc. This is a sub-directory under DCIM.
- TS3_000000. This is the first sub-directory under DCIM/100fastc, used for storing image stacks.
- hs-video. This is the directory that all AVI files are written to.
- <filename> txt. For each download, the camera creates this text file. In it are the camera setup values, including resolution, frame rate, camera name, time stamp for the capture, image processing values, color processing values, etc. (See “Appendix G: Contents of Frame.txt file .)
- <filename>.c g files. This is a binary file used for MiDAS player so that it can properly play the image files as a movie.

Note: Image files may be saved multiple times using different formats,different start and stop points, and different image processing options (brightness, contrast, gamma, color, etc.). If 10-bit images have been captured, imagery may be saved multiple times using different bit-depths.

Appendices

Appendix A: Definition of terms

Table 9-1: Definitions

Arm	**When armed, the camera will capture and write images into a partition of camera memory, and then overwrite it continually until it receives a trigger.**
Arm/Record Bug	**The Arm/Record Bug is the small vertical line used in conjunction with the Record Bar to indicate the progress of the camera while acquiring pre- and post-trigger images.**
AVI	**Audio Video Interleave (AVI) is a popular file type for electronic video. AVI files may include certain types of image/video data (compressed or un-compressed), audio data, and metadata.**
Backlight	**The Backlight is the illumination used to light the LCD display on the camera.**
Battery Status LED	**Battery Status LED States:**
Bit Depth	**Images captured by the TS3 sensor are read in binary form. Each pixel is given a binary 10-bit value from 0000000000 to 1111111111, or, in decimal form, from 0 to 1023. 0 is black, 1023 is white—all numbers in between are shades of gray from very dark to very bright. The camera operator has the option of recording all ten bits (1024 shades) or 8 bits (256 shades). If the operator chooses to record 8-bit data, they must choose which 8 bits of the ten to record. They may wish to record the Lower 8 bits, which will greatly enhance the dark areas of the image, tend to saturate the bright areas, and will expose more noise; or the Middle 8 bits, which will somewhat enhance the dark areas wash out the brighter areas, and expose some noise; or the High 8 bits, which will be the cleanest image, but with the least definition in the darker areas.**
BMP Stack	**BitMaP (BMP) files contain un-compressed image data. Each file contains one image. A BMP Stack is a collection of images. The BMP Stack produced by the TS3 is a collection of frames, written as BMP files representing a captured video sequence.**
Brightness	**Linear image control that boosts all pixel values without disturbing the slope of the curve.**
CinemaDNG	**CinemaDNG is an open digital cinema format that uses the Adobe Digital Negative Specification (DNG), widely used as an archival format for Raw images. The specification is an attempt to standardize digital commercial video format thereby simplifying collaboration and workflow across the entertainment industry and all other industries dependant on digital video recording, i.e. automobile crash testing, military testing, etc.**
Color Temperature	**The Color Temperature of an ideal black body is defined as its surface temperature in kelvins (K). The Color Temperature of a light source is an assigned value that closely approximates what a human would perceive as a match between that light source and an ideal black body at that Temperature (K). High color temperatures are seen bluish, while lower color temperatures are seen reddish.**
Config.	**Camera Configuration that can be saved and reloaded. Includes settings for Frame Rate, Resolution, Shutter Speed, Trigger, bit depth, and Auto Save.**
Contrast	**Linear image control that enhances the difference between pixel values by changing the slope of the curve, while maintaining the mean value.**
Cursor	**The cursor may be any graphic indication of where the current focus is within the user interface. This may be anything from a blinking vertical line as used within a dialog box when the user is entering text, or it may be a change in the color of a button as when navigating through menus.**

Custom Camera Control Application	**Camera control software compatible with the TS3.**
DHCP	**DHCP is a utility by which a server dynamically assigns IP addresses to clients on a network. When DHCP is selected in the Network Menu, the camera will allow a server on a connected network to assign it an IP address.**
Dialog	**A Dialog is a box that requires user input such as the selection of an option, or the entering of a number or text.**
Download	**Electronically moving image data from a camera to a "remote" device, i.e. a PC or other mass storage.**
Enable Raw	**A raw image is one where all image processing including colorization, white balance, brightness, contrast, and gamma, are all bypassed.**
File Type	**Digital files are commonly identified by their extensions. Familiar types include PDF, TXT, JPEG,TIFF, DOC, MP3, etc. Each of these files has a specified format that usually includes information in the file header and specially formatted data that applications on PCs, Cameras, Printers, Smartphones, and other electronic devices can read, write, and decipher for human viewing, editing, listening, etc.**
Gain	**In imaging the term Gain is most often used as a multiplier applied to a pixel value.**
Gamma	**Gamma encoding of images is required to compensate for properties of human vision - to maximize the use of the bits or bandwidth relative to how humans perceive light and color.[1] Human vision under common illumination conditions (not pitch black or blindingly bright) follows an approximate gamma or power function. If images are not gamma encoded, they allocate too many bits or too much bandwidth to highlights that humans cannot differentiate, and too few bits/bandwidth to shadow values that humans are sensitive to and would require more bits/bandwidth to maintain the same visual quality-**
HDMI	**HDMI, High-Definition Multimedia Interface, is used to transmit digitized video (and audio) data from the camera to a remote display. This is a popular method for connecting consumer products such as televisions, cable TV boxes, DVD players, etc.**
Image Memory	**Image memory is the internal memory in the camera reserved for raw image data. This is volatile memory that is erased when the camera is shut down.**
JPEG Stack	**Joint Photographic Expert Group (JPEG) file format is a highly compressed file format, capable of reducing image files to a fraction of the size of a BMP or lossless TIFF. The image quality of JPEGs is excellent, although there may be some discernible noise in the displayed image, often referred to as JPEG artifacts.**
Menu	**Once an item in the Menu Bar is selected, the corresponding Menu appears below.**
Menu Bar	**The Menu Bar is the bar across the top of the camera display that lists the Menu Items.**
Network	**The camera may be connected to one or more computers via its RJ45 GigE (Gigabit Ethernet) connection.**
NTP Time	**Network Time Protocol: Network Protocol for synchronizing time clocks of devices attached to a given network or internet, within a few hundredths of a second.**
Play/Review Bug	**In Review there is a progress bar that graphically indicates the position of the currently viewed frame within the image sequence. The small vertical line that is used as the indicator is referred to as the Review Bug.**
Record	**The camera is acquiring images and storing them in internal memory. This begins when the camera is armed, and ends after a trigger is received.**
Record Bar	**When the camera is Armed and it commences capturing images, the Record Bar presents a graphic indication of the progress of filling the buffer.**
Refresh Rate	**Rate at which image data is re-painted on the display. For CRTs this is analogous to the vertical frequency.**

Review	**Review is a camera utility for viewing image data while it resides in camera memory. It includes options for playing the imagery as a movie, forward or backward, or stepping through the frames one at a time, or stepping through every 10th frame. It also allows the user to adjust starting and ending points for an image sequence for viewing or saving. The user may adjust image properties such as brightness, contrast, gamma, color balance when reviewing the images. If 10 bit images have been saved, the user may also select which 8 bits to display. It is important to note that image adjustments made while using Review do not alter the image data in camera memory although they do alter the viewed and saved images.**
Save	**Moving image data from a camera's internal memory to some other mass storage device. This mass storage may be local, such as the SSD drive within the camera, or remote, such as a PC.**
SD	**This is Secure Digital memory, such as the SD Card used as a plug-in mass storage device for the camera.**
SSD	**Solid-state hard drive that is located inside the camera. This is a non-volatile mass storage device retains its data when the camera is powered down.**
Static IP	**In order for one networked device to "talk" to each other, they need to have compatible IP addresses. One way to assure this is for the user to assign unchanging (static) IP addresses to each device.**
Status Menu Bar	**The Status Bar is a line of text at the bottom of the display that appears when the camera menus are turned on.**
Sub Menu	**Within each Menu, there may be additional Sub Menus from which to select.**
TIFF Stack	**Tagged Image File Format (TIFF) is a much more flexible format than the BMP, in that it may use one of several compression schemes, may be used to store multiple images (multi-page TIFF), and may include metadata in the form of Tags. Developers may apply for their own block of private Tags. The TIFF is the only file format used in the TS3 that is compatible with 10-bit images. The TIFF Stack produced by the TS3 is a collection of frames, written as BMP files representing a captured video sequence.**
Trigger	**The trigger is a signal sent to the camera either via the trigger switch on the camera or from an external source applied to the camera's trigger input connector. When an armed camera receives a trigger, it will capture and write a prescribed number of frames into camera memory, then stop capturing images. If the TS3 receives a Trigger while in Live Mode, it will take a still image.**
Update Rate	**The rate at which the TS3 or a PC can process a new frame of video and send it to the display.**
USB	**A thumb drive or some other mass memory device may be attached via the USB port of the camera.**
USB OTG	**When a PC is connected to the USB OTG (USB On The Go) port of the camera, the camera appears as a mass storage device to the PC, much like plugging a thumb drive into a PC's USB port. The camera is automatically a slave to the PC.**
Web Application	**Camera control software that runs via web browser such as Windows Internet Explorer, Safari, Firefox, etc.**
White Balance	**Many different kinds of illumination may be used with high speed cameras. Typical color temperatures for common types of illumination are used to compute RGB gains, which, when applied to captured imagery, should approximate what a human would perceive as accurate color. The term White Balance refers to the idea that, presented with a white card under a given light source, the camera should produce a white image.**

Appendix B: TS3 Specifications

Table 9-2: Specifications

System Design		Handheld, battery-powered, portable with multiple PC I/O port
Sensor		10-bit CMOS sensor with 14 µm square pixels, color or monochrome
Resolution		1280 x 1024 pixels maximum
Light Sensitivity		3,200 ISO monochrome, 1,600 ISO color
Record Rate		24 to 500 fps at 1280 x 1024, up to 98,000 fps at reduced resolution
Shutter		Global electronic shutter from 2µsec to 41.667ms
Image Memory		4GB. Optional upgrade to 8GB
Removable Storage		SD card (SDHC: 32GB maximum), USB Flash drive
Session Length		256MB up to full image memory
File Formats		Stacks – BMP, DNG, JPEG, TIFF (processed or raw); Video – AVI, CAP (raw)
Still Image Format		JPEG
Lens Mount		C-Mount (standard), F-Mount or PL-Mount (optional
Built-in Monitor		High resolution, 178mm (7”) dia onal LCD
PC Communication Ports		USB 2.0 device (micro-B), Ethernet (10/100/1000Base-T)
Control Software		Fas*M*otion (PC application), web interface (browser on all platforms)
External I/O Sync		Trigger In/Out, Sync In/Out, Arm In/Out (LVTTL (3.3V) or switch closure)
Video Out		HDMI (1080P, 720P, 480P)
Construction		Anodized machined aluminum housing
Power		Rechargeable Li-ion battery (4+ hours operating), or 10-26 VDC external power
Power Consumption		40W maximum
Operating Environment		+5°C to +40°C
Size and Weight		228mm (9.0”) W x 114mm (4.5”) H x 89mm (3.5”) D. 1.8 Kg (3.9 lbs)
Optional Features		
WiFi		802.11 b/g/n, Security: open, WEP, WPA(2) - PSK
Image Memory		Upgrade to 8GB total
Built-In Storage		Solid State Drive (SSD) 64GB, 128GB or 256GB
Lens Mounts		F-Mount, PL-Mount
TimeStamps and Sync		IRIG-B (modulated and unmodulated)

Appendix C: TS3 Record / Resolution Tables

NOTE: These include only the preset resolution values. Many more resolutions are available in the Advanced Settings, the web-App or Fas*M*otion software.

4:3 Resolutions

Table 9-3: Resolutions, Rates, and Times

Resolution		"Frame Rate"	4GB Capacity		8GB Capacity	
H.	V.	Rate	Time (Sec.)	Frames	Time (Sec.)	Frames
320	240	60	923.4	55405	1855.1	111306
320	240	125	443.2	55405	890.4	111306
320	240	250	221.6	55405	445.2	111306
320	240	500	110.8	55405	222.6	111306
320	240	1000	55.4	55405	111.3	111306
320	240	1250	44.3	55405	89.0	111306
320	240	1500	36.9	55405	74.2	111306
320	240	2000	27.7	55405	55.7	111306
320	240	4000	13.9	55405	27.8	111306
320	240	5600	9.9	55405	19.9	111306
320	240	6130 (Max)	9.0	55405	18.2	111306
640	480	60	230.9	13855	463.9	27835
640	480	125	110.8	13855	222.7	27835
640	480	250	55.4	13855	111.3	27835
640	480	500	27.7	13855	55.7	27835
640	480	1000	13.9	13855	27.8	27835
640	480	1250	11.1	13855	22.3	27835
640	480	1932 (Max)	7.2	13855	14.4	27835
800	600	60	147.8	8868	296.9	17815
800	600	125	70.9	8868	142.5	17815
800	600	250	35.5	8868	71.3	17815
800	600	500	17.7	8868	35.6	17815
800	600	1000	8.9	8868	17.8	17815
800	600	1250	7.1	8868	14.3	17815
800	600	1284 (Max)	6.9	8868	13.9	17815
1280	1024	60	54.1	3247	108.7	6524
1280	1024	125	26.0	3247	52.2	6524
1280	1024	250	13.0	3247	26.1	6524
1280	1024	500	6.5	3247	13.0	6524
1280	1024	506 (Max)	6.4	3247	12.9	6524

16:9 Resolutions

Resolution		"Frame Rate"	4GB Capacity		8GB Capacity	
H.	V.	Rate	Time (Sec.)	Frames	Time (Sec.)	Frames
320	200	60	1108.0	66481	2225.9	133556
320	200	125	531.8	66481	1068.4	133556
320	200	250	265.9	66481	534.2	133556
320	200	500	133.0	66481	267.1	133556
320	200	1000	66.5	66481	133.6	133556
320	200	1250	53.2	66481	106.8	133556
320	200	1500	44.3	66481	89.0	133556
320	200	2000	33.2	66481	66.8	133556
320	200	4000	16.6	66481	33.4	133556
320	200	5600	11.9	66481	23.8	133556
320	200	7295 (Max)	9.1	66481	18.3	133556
800	480	60	184.7	11084	371.1	22268
800	480	125	88.7	11084	178.1	22268
800	480	250	44.3	11084	89.1	22268
800	480	500	22.2	11084	44.5	22268
800	480	1000	11.1	11084	22.3	22268
800	480	1250	8.9	11084	17.8	22268
800	480	1602 (Max)	6.9	11084	13.9	22268
1024	600	60	115.5	6928	232.0	13918
1024	600	125	55.4	6928	111.3	13918
1024	600	250	27.7	6928	55.7	13918
1024	600	500	13.9	6928	27.8	13918
1024	600	1000	6.9	6928	13.9	13918
1024	600	1052 (Max)	6.6	6928	13.2	13918
1280	720	60	77.0	4618	154.7	9279
1280	720	125	36.9	4618	74.2	9279
1280	720	250	18.5	4618	37.1	9279
1280	720	500	9.2	4618	18.6	9279
1280	720	719 (Max)	6.4	4618	12.9	9279

1:1 Resolutions

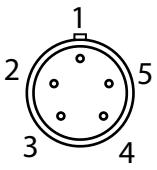
Resolution		"Frame Rate"	4GB Capacity		8GB Capacity	
H.	V.	Rate	Time (Sec.)	Frames	Time (Sec.)	Frames
256	256	60	1082.4	64942	2173.8	130428
256	256	125	519.5	64942	1043.4	130428
256	256	250	259.8	64942	521.7	130428
256	256	500	129.9	64942	260.9	130428
256	256	1000	64.9	64942	130.4	130428
256	256	1250	52.0	64942	104.3	130428
256	256	1500	43.3	64942	87.0	130428
256	256	2000	32.5	64942	65.2	130428
256	256	4000	16.2	64942	32.6	130428
256	256	5600	11.6	64942	23.3	130428
256	256	6704 (Max)	9.7	64942	19.5	130428
512	512	60	270.6	16237	543.7	32619
512	512	125	129.9	16237	261.0	32619
512	512	250	64.9	16237	130.5	32619
512	512	500	32.5	16237	65.2	32619
512	512	1000	16.2	16237	32.6	32619
512	512	1250	13.0	16237	26.1	32619
512	512	1500	10.8	16237	21.7	32619
512	512	2000	8.1	16237	16.3	32619
512	512	2126 (Max)	7.6	16237	15.3	32619
1024	1024	60	67.7	4059	136.1	8155
1024	1024	125	32.5	4059	65.3	8155
1024	1024	250	16.2	4059	32.6	8155
1024	1024	500	8.1	4059	16.3	8155
1024	1024	618 (Max)	6.6	4059	8.2	8155
5:1 Resolution						
1280	256	60	216.5	12989	434.9	26095
1280	256	125	103.9	12989	208.8	26095
1280	256	250	52.0	12989	104.4	26095
1280	256	500	26.0	12989	52.2	26095
1280	256	1000	13.0	12989	26.1	26095
1280	256	1250	10.4	12989	20.9	26095
1280	256	2000	6.5	12989	13.0	26095
1280	256	2005 (Max)	6.5	12989	13.0	26095

Appendix D: Power and I/O Connections

Power Connections For the TS3

Table 9-4: Power Pin OUt

(View from Solder cup side of connector)



Use Lemo 1B.305 compatible plug (FGG.305.CLAD.42.NZ Pictured here)

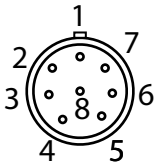
Refer to //http www.lemo.com

Pin	Signal
1	+12 to 24VDC
2	+12 to 24VDC
3	No Connection
4	Ground
5	Ground

I/O Connections: Sync and Trigger

Table 9-5: I/O Connector Pin Out

(View from Solder cup side of connector)



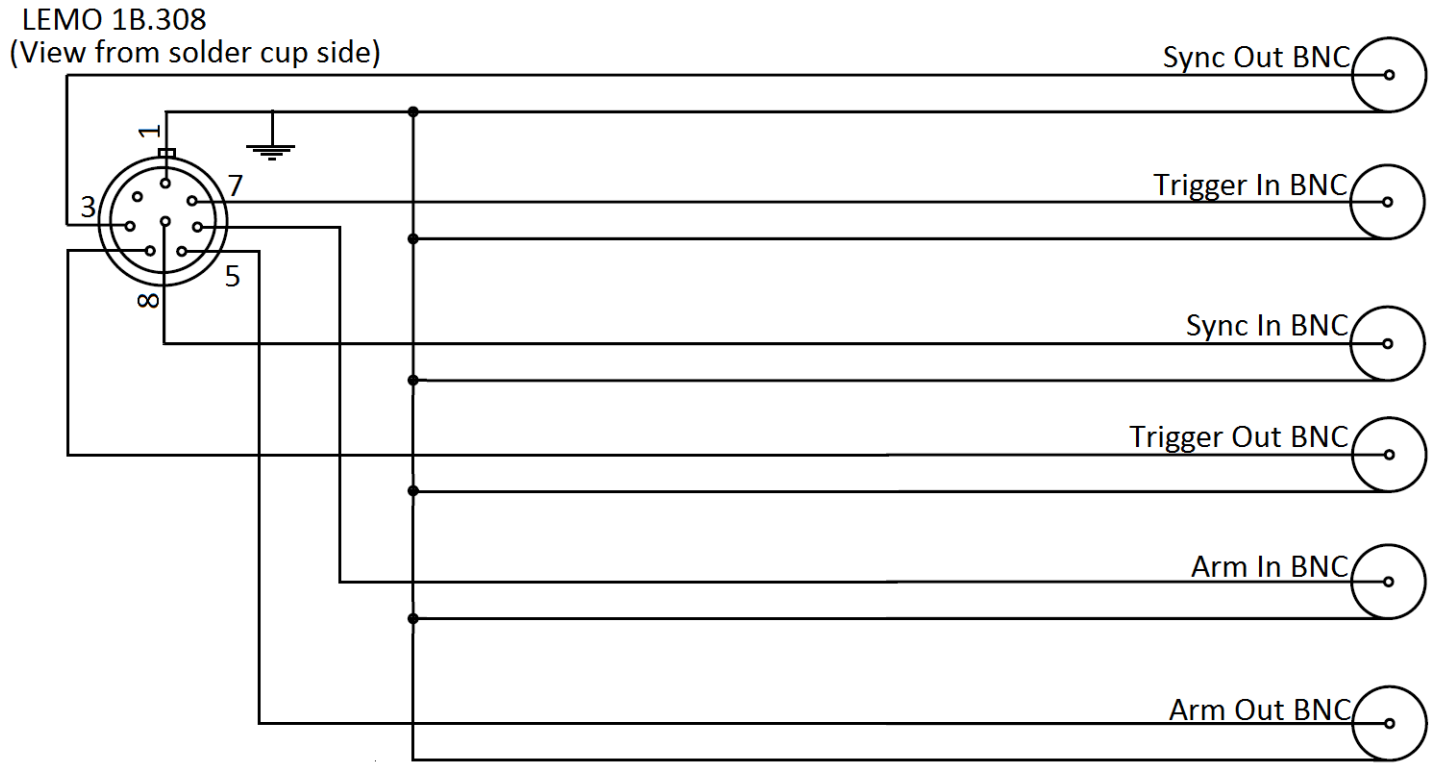
Use Lemo 1B.308 compatible plug

Refer to http://www.lemo.com

Pin	**Signal**
1	Ground
2	Analog Reserved
3	LVTTL **Sync Out**
4	LVTTL Reserved
5	LVTTL Reserved
6	LVTTL Reserved
7	LVTTL **Trigger In**
8	LVTTL **Sync In**

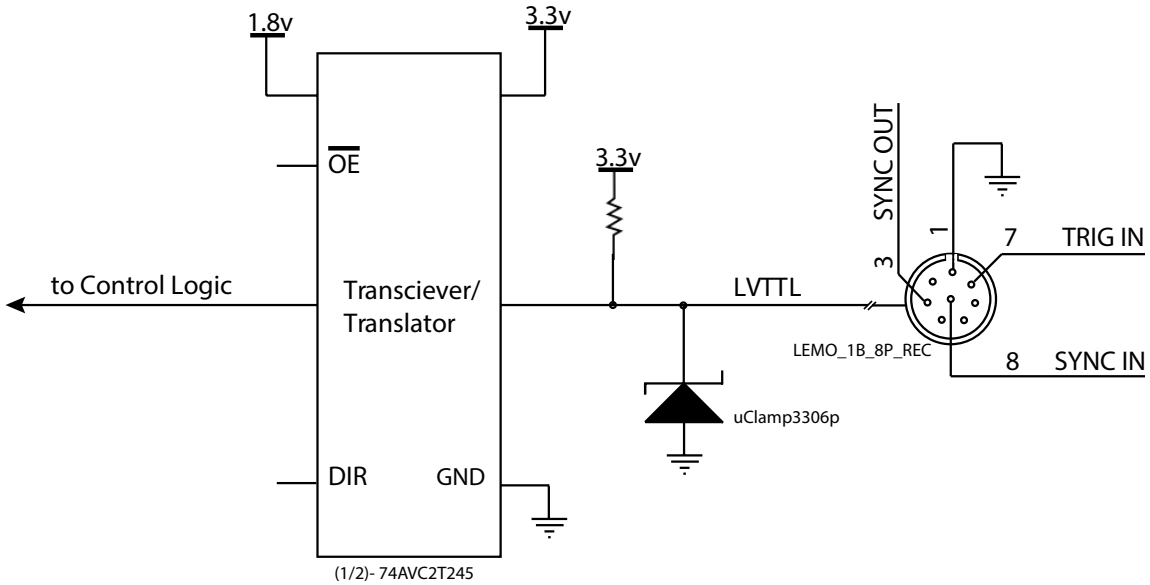
The TS3 is shipped with a Sync I/O cable for connecting external Trigger, Sync Out, and Sync In signals. The cable has a LEMO connector for the TS3 end and BNC connectors for the three signals.

Figure 9-1: Sync I/O Cable Drawing



(This drawing depicts a 6-signal cable that exposes all available I/O channels. Cameras are shipped with the standard 3-signal cable that exposes Sync Out, Trigger In, and Sync In.)

Figure 9-2: Sync I/O Camera Interface Schematic



The TS3 I/O circuits are designed to operate at LVTTL levels (3.3v). The inputs will respond to simple switch closures.

NOTE: THESE I/O PORTS ARE FOR LVTTL LEVELS ONLY. VOLTAGES ABOVE 3.3V WILL HARM THE TS3.

There is an I/O conditioning accessory available from MIKROTRON that accepts signals up to 24v. The conditioner uses opto-isolators to protect the camera from over-voltage.

Appendix E: Adjusting Back Focus

Symptoms of incorrect Back Focus Adjustment:

- Zoom lenses loose focus when zooming in or out. (Not all zoom lenses are designed to remain focused, so be careful not to prematurely jump to the conclusion that the back focus needs adjustment.)
- Lenses will not focus at infinit .
- The witness marks (distance marks) on lenses are always off in the same di ection

Figure 9-3: Focus Chart

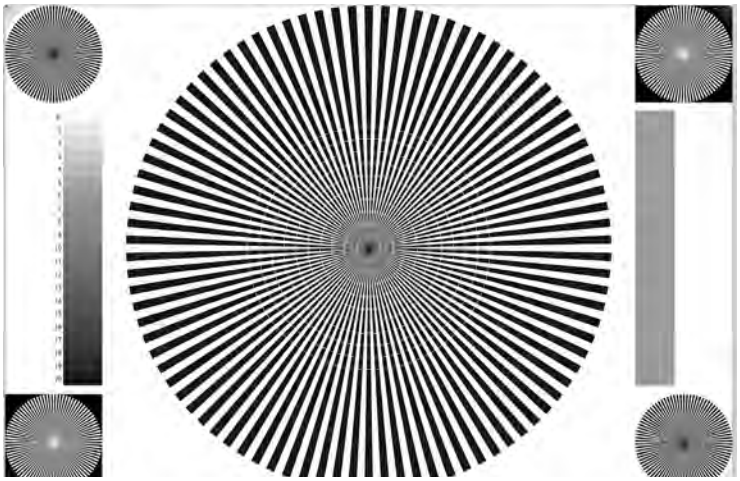
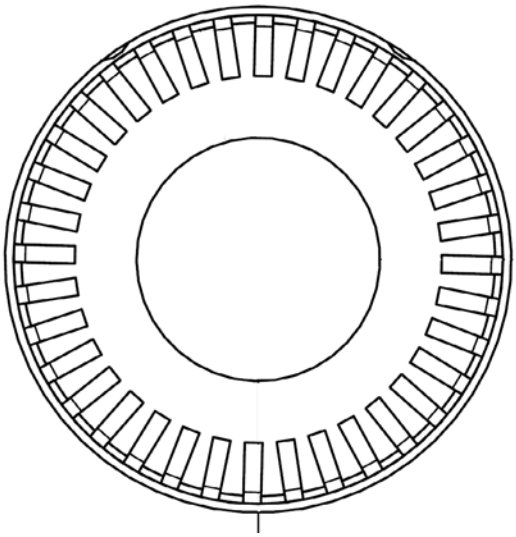


Figure 9-4: C-Mount



Tools required for Back Focus Adjustment:

- High quality lens--or lens that you need to use for a particular test --Best if it is very fast--f/1.4 or faster.
- A high quality focus chart can be very helpful. In a pinch, you can print one yourself. An 8 1/2 x 11" or A-Size Seimens Star chart will work for the example here.
- A 3/32" hex allen wrench for the C-mount lock screws. (See "TS3 Top View" on page 4 and "TS3 Bo om View" on page 5.)

Adjustment procedure:

1. Connect the TS3 to an LCD display, either via a PC connection or the HDMI port. You will wish to have a very good view of the image--the larger the better.
2. Select the lens you wish to use. For our discussion we will use a 1" format Navitar 50mm f/.95 lens.
3. Decide on a distance. For this discussion we will use 5', or 1.5m.
4. Set your target 5' / 1.5m from the target. The proper way to measure is from the image plane to the target. The image plane would be about 17.5 mm behind the face of the C-mount. Set the target as flat and square to the camera as possible. Usually, taping it to a wall is the easiest.
5. Get plenty of flat white light on the target.
6. Set the TS3 up to frame the image. Using a 50 mm lens at 1.5m, the field of view at 800 x 600 resolution will be just a little larger than the focus chart. Use smaller resolutions to zoom-in for fine adjustment.
7. Make a reference mark on the C-mount adapter to mark your starting point. This can be done with a little dab of white out, or a small piece of tape.
8. Frame and focus the camera on the focus target.
9. Set the lens aperture wide open: f/.95 for this lens.

10. Adjust the illumination and/or the exposure setting to get the right exposure, avoiding saturation. (Keep the lens set at its largest aperture. It is important to use the shallowest depth of focus possible.)

11. Look at the witness mark on the lens. It should be pointing o 5'/1.5m. If it is not, continue on with the adjustment.

12. Set the lens to the 5'/1.5m witness mark.

13. If the focus got noticeably worse, go on with the adjustment.

14. Loosen the two C-Mount Lock screws (see "Figure 1-3: TS3 Top View" and "Figure 1-3: TS3 Top View"). The C-Mount is threaded onto the TS3 Optional Block. Loosening the screws enable turning the C-Mount for adjustment.

15. Turn the C-mount adapter a short distance one direction, then back to where it was, then the other direction. You will quickly learn which way to turn it to get better results.

Note: The C-mount has 3/32 threads on it. It also has a scalloped pattern on its edge comprising 36 indentations. Rotating the mount the distance of one of these indentations is equivalent to adjusting the back focus distance a .022mm or a little less than .001 " It is a good goal to adjust the back focus to within a couple of these indentations, or less than .05mm / .002 "

16. When you are satiffied that the back focus is adjusted as well as you can get it, tighten the two adjustment screws and reconfirm the focus.

Setting for Infinity

If you will be using the TS3 exclusively for close by objects and are satisfied that the back focus is correct, you may skip this part. If, however, you will be using the camera for activities where it will be imaging far away objects, you will want to confirm that it can focus at infinit .

Figure 9-5: Navitar 50mm f/95 Lens

To do this you will need to find a place where you can set the camera up that has a good view of objects at various distances.

17. Check the location of the reference mark made on the lens in #7, above.

18. Look at the last witness mark on the lens before infinity. Find an object in your field of view that is approximately the distance indicated by that last witness mark. For example on the Navitar 50mm f/.95 lens, the last witness mark before infinity is 10m. So you would find an object approximately 10m away and focus on it.

19. Is the lens now set close to the 10m witness mark? Continue findin targets farther and farther away to get a feel for how far the lens can focus to.

If the best focus for very far objects is at or a tiny bit before the infinity stop, the lens is OK. If you find that the best focus for the farthest objects is not close to the infinity stop, or you find that you just cannot focus on far away objects, repeat #14 through #16 above.

Appendix F: Camera Status LEDs

Figure 9-6: Camera Status LEDs

Power	Network	Disk	Camera	Sync	Battery

Power LED:		Solid Green whenever the TS3 is powered up.
Network LED:		Fast blinking Amber whenever the TS3 is sending or receiving on the network.
Disk LED:		Fast blinking Amber whenever the TS3 SSD or SDHC are accessed.
Camera LED:		Solid Green whenever in LIve mode (operating, but not recording).
		Blinking Amber slowly (1 Hz) when the TS3 is Armed (recording, not triggered).
		Blinking Amber quickly (2 Hz) when the TS3 is Triggered.
		Blinking Purple slowly (1 Hz) when the TS3 is Armed in Autosave (recording, not triggered).
		Blinking Purple quickly (2 Hz) when the TS3 is Triggered in Autosave.
		Solid Amber when in Review mode (playing back recorded images).
		Off when battery is charging
Battery LED:		Blue when no battery is present
		Solid Green when in operation and battery charge is above 15%.
		Solid Amber when in operation and battery charge is above 5%, below 15%
		Blinking Red when in operation and battery charge is below 5%
		Blinking Green when charging above 15%
		Blinking Amber when charging above 5%, below 15%
		B linking Red when charging below 5%

Appendix G: Contents of Frame.txt file

[Image]

roi_x=0
roi_y=0
width=1280
height=1024
bit_mode=upper 8
frame_count=345
trigger_frame=344
time_ tamp=Thu Oct 6 12:27:48 2011

[Camera]

make=MIKROTRON
model=TS3
fpga_rev=0x00010040
software_version=000.001.002mac_
address=a4:1b:c0:00:00:17
camera_name=TS3-c
sensor_type=C31L

[Record]fps=500

shutter_speed=200
0 multi_slope=0:
trigger_settings
sync_in=0x0
sync_out=0x0

[Normalization

red_balance=256
blue_balance=256
green_balance=256
brightness=100
contrast=100
gamma=100
sensor_gain=0
red_gain=1
green_gain=1
blue_gain=1
red_matrix[256,0,0]
blue_matrix=[0,0,256]
green_matrix=[0,256,0]
raw=0
codec=BMP

Appendix H: TS3 Updates

From time to time there will be camera software updates. These updates will come in the form of files that are made available via FTP or some other means.

If you are notified by MIKROTRON or one of its distributors that an update is available, they will let you know where the file is located and how to download it to a PC running Windows Vista or Windows 7. The PC will need to have a an SD Card port or have a card reader attached to it.

Table 9-6: Information Status

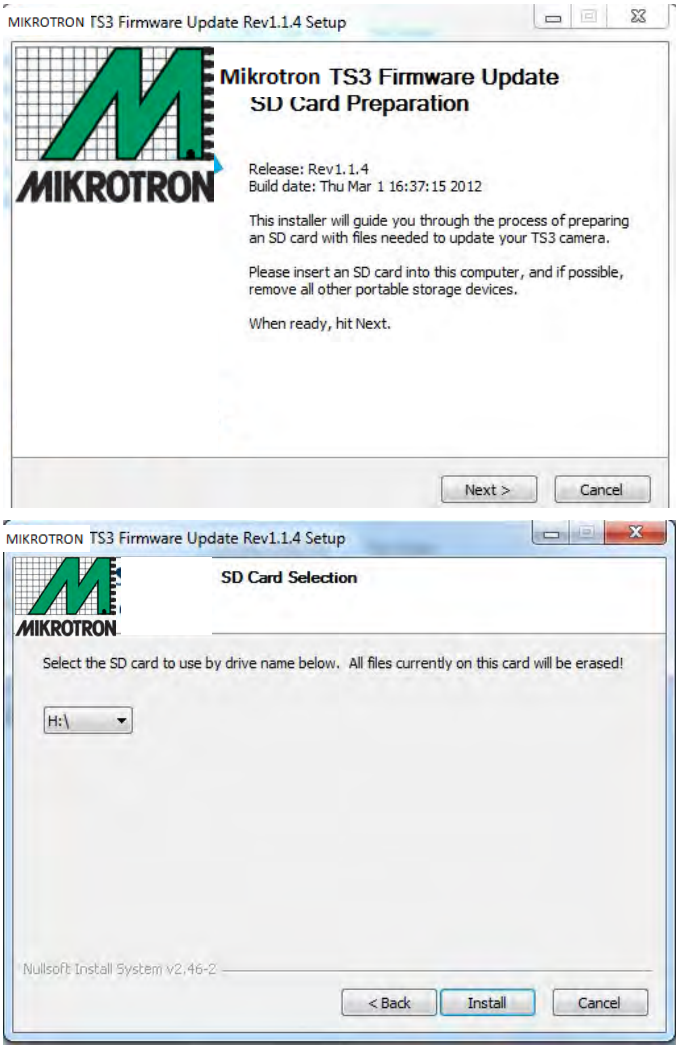
TS3-08	
mikrotron -TS3100XC8064	
MAC Address:	a4:1b:c0:00:00:08
Software Version:	1.1.4
FPGA Version:	0.1.90
Sensor Version:	L1300C-A2-0030
GigE Vision Version:	1.02
Bootloader Version	Sep 28 2011 - 09:39:2
Batter SerialNo:	FA1 3900008

Update Procedure:

1. Navigate to System/Information/Status to see the current Software Version of your TS3.
2. Power down the TS3.
3. Download the update file to a Windows PC. The update file name will be in the form of "ts3_revx.x.x_<Year>_<date>.exe." For example, the latest revision as of the 1st of March, 2012 is: ts3_rev1.1.4_2012_0301.exe.
4. Attach an SDHC card to the PC. If the PC does not have a built in card reader, you may attach a USB card reader to it. **Please note the drive letter the PC assigns the card**.

Note: There are two options for formatting the SD Card using System/Storage/Format: "Compatibility " (FAT32), and "Performance" (EXT2). In order to be used for the update process the SD Card must be formatted using the "Compatibility " (FAT32) option.

Figure 9-7: Camera Update Screens


MIKROTRON TS3 Firmware Update Rev1.1.4 Setup
Mikrotron TS3 Firmware Update
SD Card Preparation
MIKROTRON
Release: Rev1.1.4
Build date: Thu Mar 1 16:37:15 2012
This installer will guide you through the process of preparing an SD card with files needed to update your TS3 camera.
Please insert an SD card into this computer, and if possible, remove all other portable storage devices.
When ready, hit Next.
Next >
Cancel
MIKROTRON TS3 Firmware Update Rev1.1.4 Setup
SD Card Selection
MIKROTRON
Select the SD card to use by drive name below. All files currently on this card will be erased!
H:\
Nullsoft Install System v2.46-2
< Back
Install
Cancel

5. Double click on the update file. The Update Screen will appear. Click Next.
6. A License Agreement will appear. Click the check box to accept the terms and click Next.
7. A screen will appear for selecting the SD Card. **Make sure that you have selected the correct drive letter before clicking on Install.** A new window with a progress bar will appear.
8. Once the update program has finished writing to the SD Card, a final screen will appear. Click on Finish. Remove the SD Card from the PC.
9. Insert the SD Card into the SDHC slot of the TS3.
10. Power up the TS3 while pressing the Up Arrow on The D-Pad. When the camera boots up, you will see a blue update screen and a progress bar. When it is finished the camera will boot normally.
11. After the camera boots up, navigate to System/Configuration and select reset. This will load valid factory default parameters into the camera.
12. Power Cycle the camera (turn it completely off, then reboot.)
13. Navigate again to System/Information/Status to see the new Software Version of your TS3.
14. Re-format the SD Card before using it for image file storage.

Appendix I: Physical Measurements

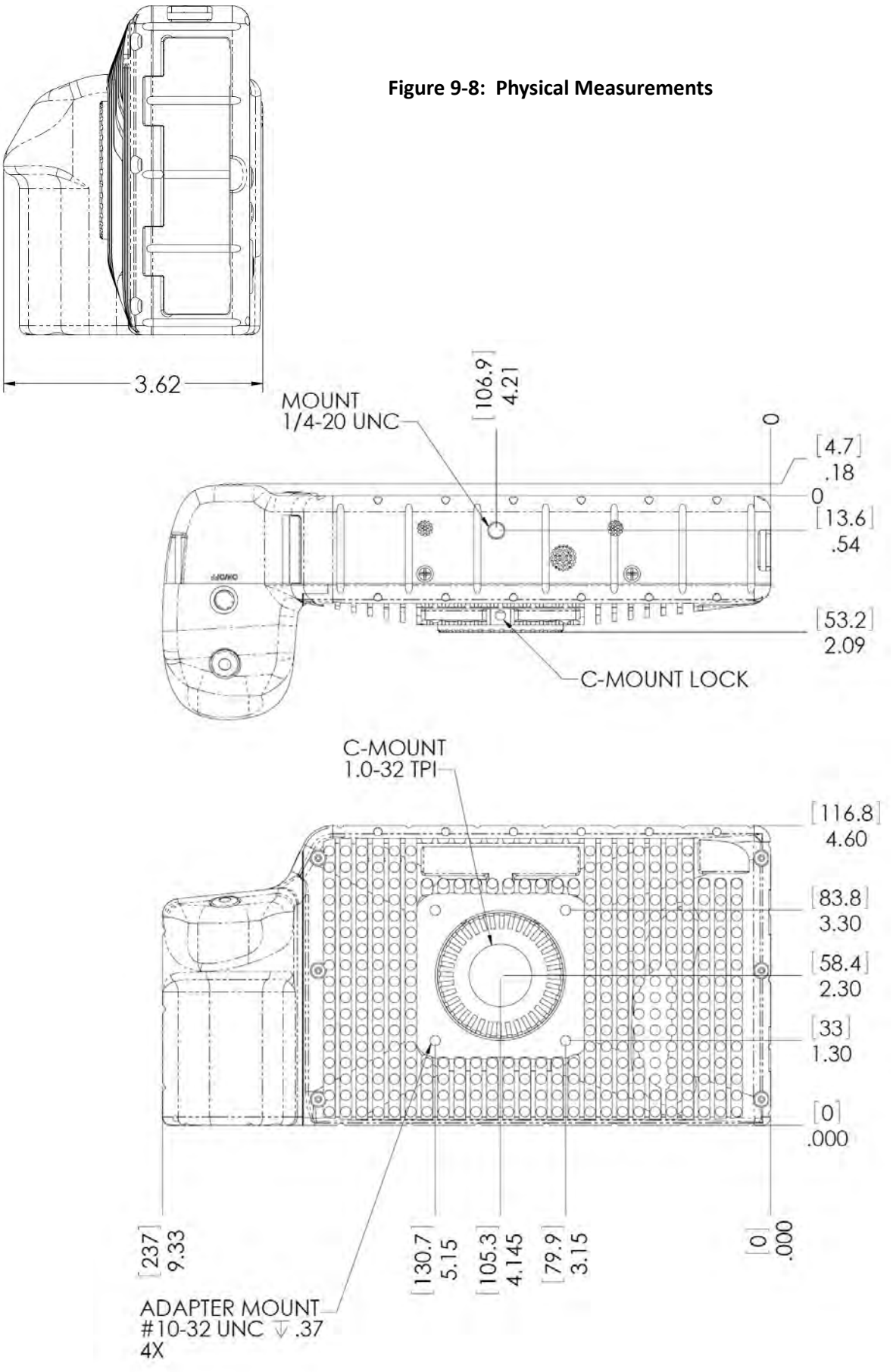


Figure 9-8: Physical Measurements

Appendix J: Crop Factor

Crop Factor is a term used in digital photography that expresses the size of the sensor image plane as compared to that of 35mm film. In Figure 9-9 through Figure 9-11, below, the Black border represents the image on 35mm film, the Red border represents the image on the sensor using the same focal length lens.

Diagonal of 35mm film / Diagonal of the Sensor area used = Crop Factor

The diagonal of 35mm film is 43.3, compared to the 22.95mm diagonal of the TS3, you get a crop factor of 1.89:

43.3mm / 22.95mm = 1.89

The photographic advantage of knowing the crop factor is that if you know the lens you would use for a given field of view with a 35mm camera, you can divide the crop factor into that number to give you the focal length of the lens with the same field of view for your TS3. For example, if you are using a 125mm lens on your 35mm SLR, you will need about a 65mm lens on the TS3 at full resolution (125mm / 1.89 = 66.14).

Table 9-7: Crop Factor

H-Res	V-Res	Diagonal	Crop Factor
1280	1024	22.95	1.89
1280	720	20.56	2.11
1024	1024	20.27	2.14
1280	256	18.27	2.37
800	600	14.00	3.09
1024	600	16.62	2.61
640	480	11.20	3.87
800	480	13.06	3.32
512	512	10.14	4.27
320	240	5.60	7.73
320	200	5.28	8.20
256	256	5.07	8.54

Figure 9-9: Crop Factor 1280 x 1024

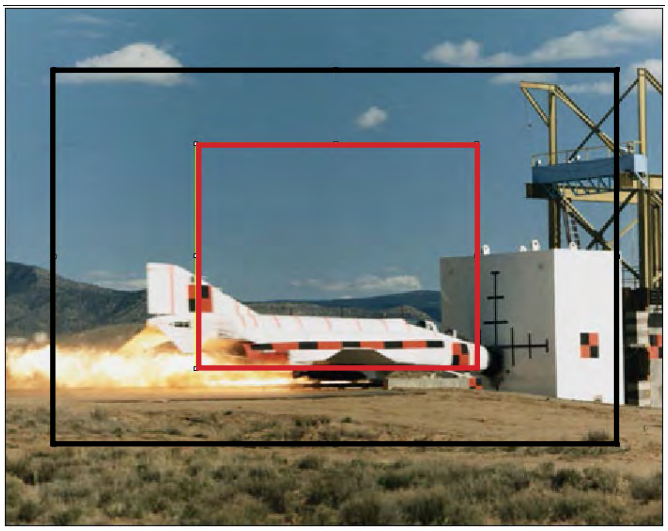


Figure 9-10: Crop Factor 1280 x 720

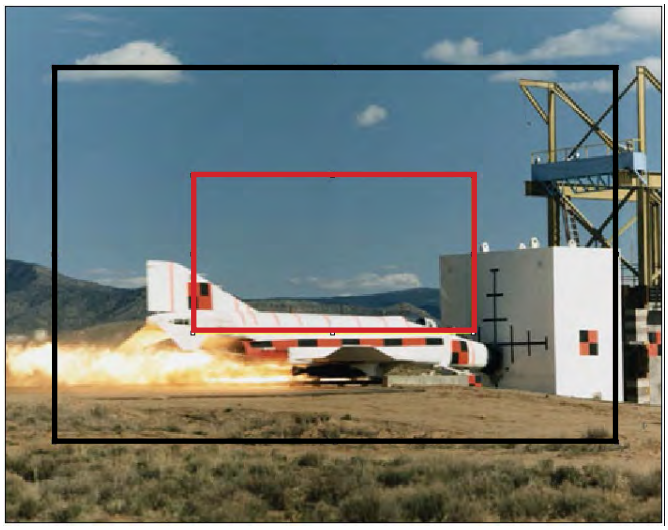
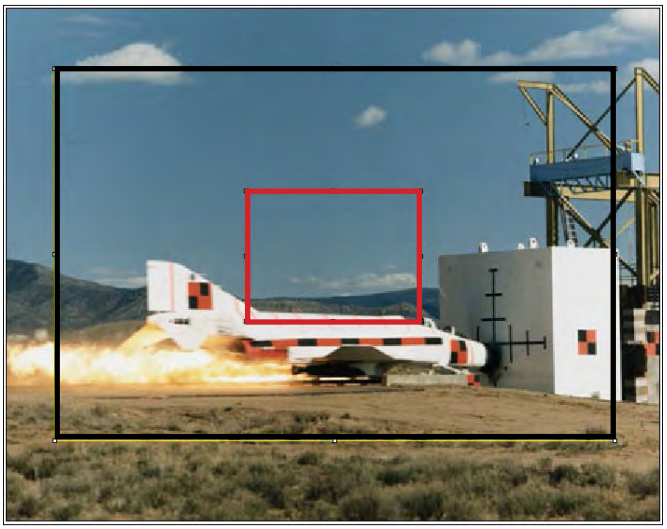


Figure 9-11: Crop Factor 800 x 600



Appendix K: Partition Capture (CAP) File Format

Partition Capture file format is a MIKROTRON proprietary raw data format used to store image data gathered by the TS3 in one “Session” into the camera’s built-in SSD drive. The session length is set by the user (see “3-8 Storage Setup” on page 20) to any multiple of 256MB up to the memory capacity of the camera, which is either 4GB or 8GB. The actual length of a recorded session may vary, however, depending on whether the full allotment of pre-trigger frames were captured before the trigger was asserted (see “Application Note 3: Trigger Position and the Circular Buffer” on page 97).

There are three major distinguishing benefits of CAP file

1. CAP file transfer time from DRAM to SSD is the shortest of all of the uncompressed file types
2. CAP files are the only files that may be copied back into DRAM from the SSD and played back from the camera or on a PC via the camera.
3. CAP files a e the only uncompressed single file format available from the camera.

Figure 9-12: CAP File Diagram

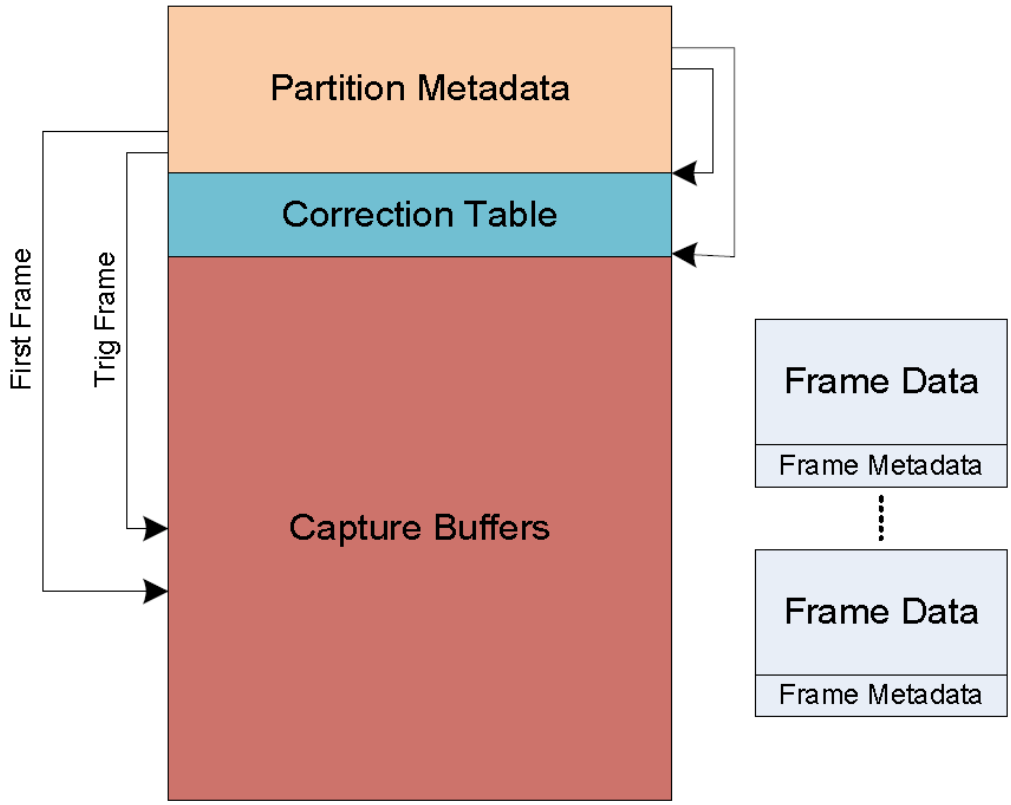


Table 9-8: CAP File Format

Field	Size	Description
Manufacturer's name	32	"MIKROTRON".
Model name	32	"TS3100SC8064" for example.
Serial number	16	"0.0.122.A3" for example.
Application version	32	"1.5.8" for example.
Camera name	16	"MikrotronA4-7A" for example.
Ethernet MAC address	6	The MAC address of the camera.
Bit selection	1	0:Low8, 1:Mid8, 2:High8, 3:10Bits
Sensor gain	1	The gain used by the sensor (analog gain).
FPGA version	4	FPGA version information
ROI x-offset	2	Left side of the ROI window.
ROI y-offset	2	Top side of the ROI window.
ROI width	2	Width of the ROI window.
ROI height	2	Height of the ROI window.
Frames per second	4	Number of frames per second.
Shutter speed	4	Exposure time in microseconds.
Sensor type	4	Type of sensor used, "L13C" for example.
GPS location	64	GPS location information
Frame count	4	Total number of frames captured.
Frame size	4	Size of the frames in quadwords.
First frame	4	Frame number of the first frame in the capture buffer.
Trigger frame	4	Frame number of the trigger frame in the capture buffer.
Trigger time seconds	4	Linux time of the trigger event.
Trigger time nanoseconds	4	Nanoseconds of trigger event from last second.
Start of video	4	Start of capture buffer, in quadwords.
As-shot neutral	12	The AsShotNeutral value.
Matrix coefficients	36	IPM matrix coefficients.
White balance gains	12	IPM white balance gain setting
Multislope settign	2	LUPA 1300-2 multislope setting
Trigger setting	1	
SyncIn setting	1	
SyncOut setting	1	
Brightness	1	0-255 centered around 128.
Contrast	1	0-255 centered around 128.
Gamma	1	0-250 centered around 100.
RGB gain setting	3	Red, green, blue gain setting
FPN setting	1	Off, sensor or pixel correction
Correction table offset	4	Offset to the correction table.
Correction cable length	4	Size of the correction table, in quadwords.

Application Notes

Application Note 1: Histograms

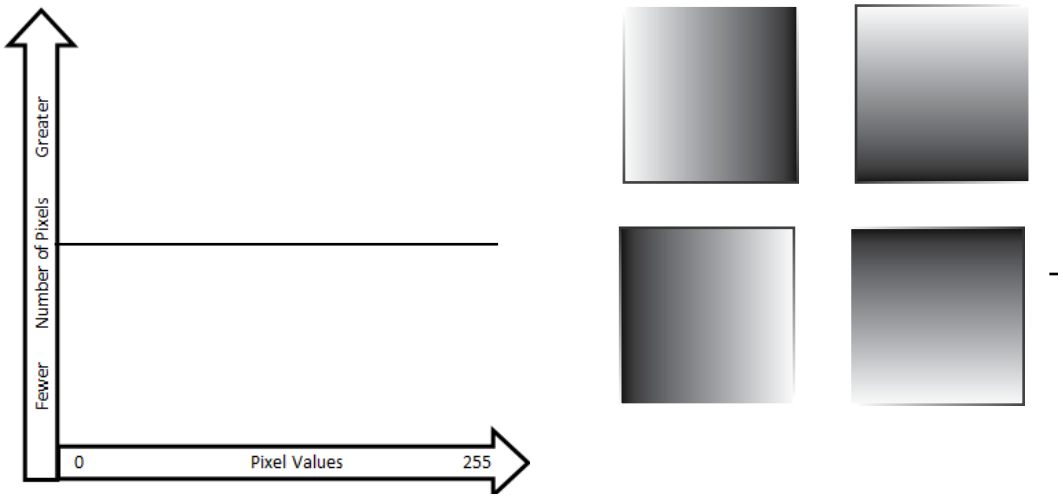
Histograms are available on the TS3 to help the user assess the lighting and color balance of the scene framed by the camera. This App Note is provided to help the TS3 user understand the information provided by histograms and to offer some basic guidance on their use.

Histograms are available on cameras with Mono and Color sensors. Histograms for Color cameras use Red, Green, and Blue lines to represent the RGB pixel values, while histograms for Mono cameras use a single black line to represent all pixel values.

Note: Histograms on the TS3 always shows pixel values 0-255. When the camera is recording in 10-bit mode, the histogram uses high, med, or low 8-bits, depending on the Display setting

Mono Histograms:

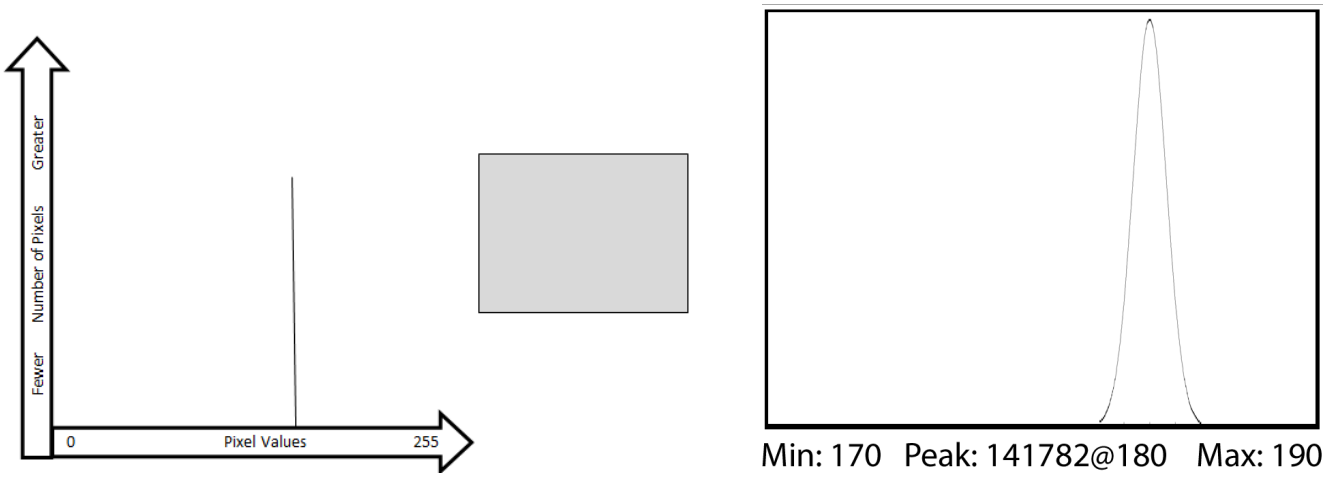
Figure 10-1: Histogram: Linear Gradient



The Mono histogram is a simple single-line graph. The Y-axis (vertical) represents the number of pixels. The X-axis (horizontal) represents pixel values. The first thing to understand is that the histogram offers quantitative information only; it includes no spatial information. Looking at a histogram gives you no idea of the location of bright or dark pixels in the image.

A histogram of a perfect linear gradient, regardless of its orientation would be a straight horizontal line because there would be exactly the same number of pixels of each value.

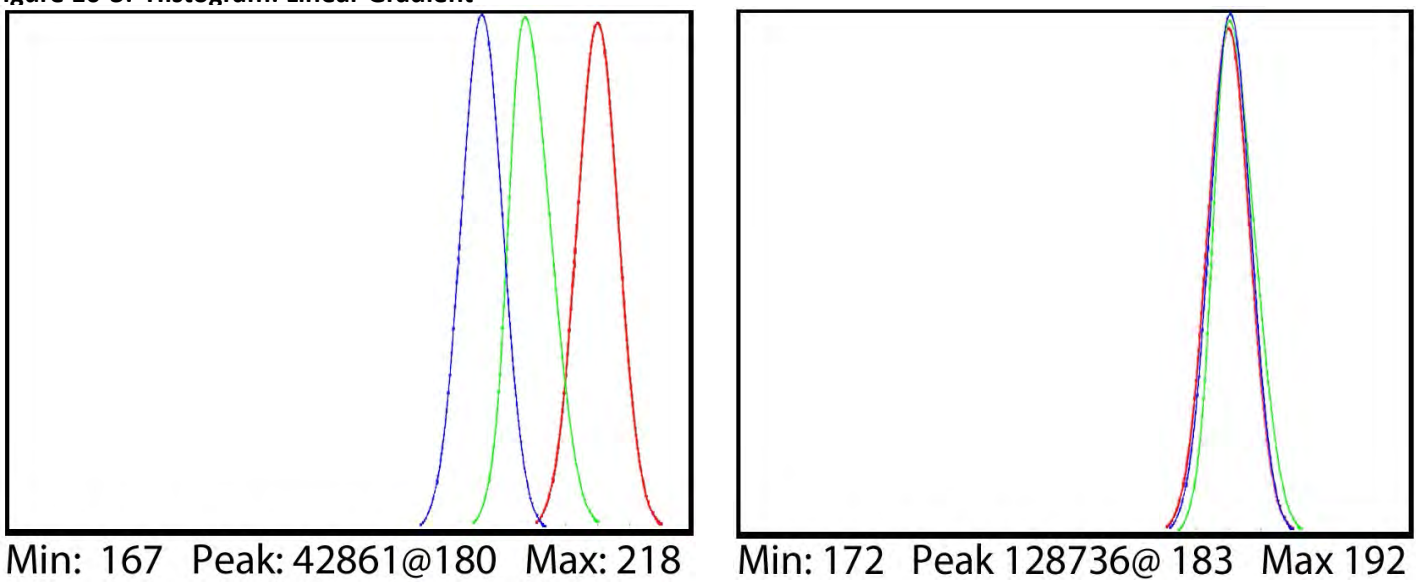
Figure 10-2: Histogram: Mono-tonal



The histogram of a perfect mono-tonal image, is a straight vertical line because all of the pixels have

the same value. In practice, because it is unlikely we will be able to image a perfectly flat field, the histogram of a mono-tonal image will be a bell curve. The histogram shown to the right in Figure 10-2 is in the format used on the TS3. It shows minimum, maximum and peak values for the image. The peak value also includes the number of pixels exactly at the peak value: Peak: <# of pixels>@<pixel value>.

Figure 10-3: Histogram: Linear Gradient



If we view the same mono-tonal content used in Figure 10-2 on a color camera, we get the more complex histograms seen in Figure 10-3.

Assuming that the mono-tonal image is a neutral gray target, the histogram on the left shows what you would expect if the camera's color balance is shifted a bit toward the red, as it might be under tungsten illumination. In this ase the color channels are easily visible as they are separated. The histogram on the right shows what you would expect if the camera's color balance is a good match.

Histograms and Exposure Setting

Professional Digital photographers are very sophisticated in their use of histograms. While the use of histograms as a tool for fine-tuning light and color content for artistic purposes is beyond the scope of this App Note, there are a couple of simple rules to follow that will be helpful.

1. The best images contain a balance of highlights and lowlights. To this end it is good to strive for a distributed grouping of peaks across the histogram.
2. Try to identify the peaks for any objects of interest in the scene. Make sure that those objects are not in danger of exceeding the camera's dynamic range--that they are not close in value to either 0 or 255.
3. Avoid Min: 0. If the minimum pixel level is 0, you know that some pixels are registering no light at all. If there are some very dark areas in the scene, you might expect this and accept it. But if the scene is more uniform and you need to be able to bring out details in the dark areas, avoid Min: 0, as no amount of gamma or brightness adjustment will help. If you are recording in 10-bit mode and viewing the upper 8-bits, you may wish to view mid- and low-8 bit settings just to see if you are truly at Min: 0
4. Avoid Max: 255. Once an area reaches saturation (255), it is game-over in terms of image processing. In color images this may even result in some color shifting as one color may easily saturate before the others.

Application Note 2: Understanding Bit Depth

Each pixel in a digital image has a numeric value. Low numbers represent dark pixels; higher numbers represent brighter ones.

Mono images that we see displayed on computer screens use 256 shades of gray. The pixel values range from 0 to 255. Color images use 256 shades each of red green and blue. With 256 (red) x 256 (green) x 256 (blue), color images may use more than 16 million colors!

The TS3 sensor outputs 10-bit image data. This represents 1024 shades of gray for mono, and 1024 shades each for Red, Green, and Blue for color-- that would be 1024^3... over a billion colors!

Decimal numbers 0 to 1023 are expressed 0000000000 to 1111111111 in binary. Each binary digit is a "bit." So a 3 bit number, 000 to 111, is the equivalent to decimal 0 to 7. An 8-bit number, 00000000 to 11111111, is the equivalent to decimal 0 to 255. A 10-bit number is equivalent to decimal 0 to 1023.

Because we will be accessing the imagery on devices such as computers and LCD screens like the one on the TS3, that can only display 256 shades of gray (or 256^3 colors) one valid option is o save only 8 of the 10 bits produced for each pixel of the sensor. If we choose this option, we will need to decide which 8 of the 10 bits to save. There are three choices:

1. **High 8-bit** (dropping the two least significant bits and saving the high-order bits):

11111111~~11~~

In this case we have a mapping that looks like this:

10-bit (1024) values (in decimal): 0 1 2 3 4 5 6 7 8 9 10 11 .....511.....1023

8-bit (256) values (in decimal): 0 0 0 0 1 1 1 1 2 2 2 .....127.....255

Note that for the 10-bit image 0 is black 511 is midway to saturation (white) and 1023 is at saturation. For the 8-bit image 0 is black, 127 is midrange and 255 is white--the two images would appear the same to us.

2. **Mid 8-bit** (dropping the least significant bit and the most significant bit, saving the Mid-order bits):

~~1~~11111111~~1~~

In this case the mapping looks like this:

10-bit (1024) values: 0 1 2 3 4 5 6 7 8 9 10 11.....255.....511.....1023

8-bit (255) values: 0 0 1 1 2 2 3 3 4 4 5 5.....127.....255

Note that while we have the same starting point (black = 0), saturation new comes at the midrange of the original 10-bit data. Compared with the High 8-bit mapping, this image has twice as steep a response slope--it is much brighter. This brightness will come at the cost of seeing more noise, however.

3. **Low 8-bit** order bits (dropping the two most significant bits and saving the lower 8):

~~11~~11111111

10-bit (1024) values: 0 1 2 3 4 5 6 7 8 9 10 11.....255.....512.....1023

8-bit (255) values: 0 1 2 3 4 5 6 7 8 9 10 11..... 255

As with the other mappings, black is black = 0, but with the Low 8-bit mapping, saturation comes twice as fast as with the Mid 8-bit and 4x as fast as with the High 8-bit.

Figure 10-4: High...Mid...and Low 8 Bits of the same Image

Application Note 3: Trigger Position and the Circular Buffer

Capturing a high-speed event can be a tricky proposition. Often high speed events that we are interested in happen without warning. Other times high speed events are tightly controlled. The TS3 is designed to handle myriad scenarios. Here are several examples:

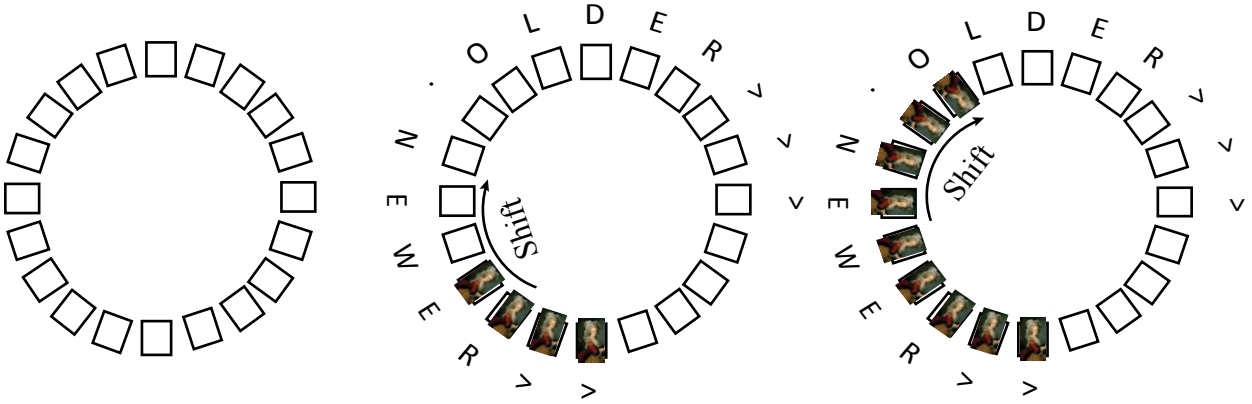
Example 1: Someone is blowing up a balloon until it pops. You want to capture the balloon pop. You have a partition of memory with one second of record time. It is very difficult to estimate within a second when that balloon is going to pop!

Example 2: Jams happen once or twice a day on an automated production line. When they occur, they may set off a chain of vents that you would like to capture. The jam is detected by sensors on the machinery that is propagated to various parts of the line. You need to image the time just before the jam occured to help understand the cause. You are equally as interested to capture the time just after the event to understand how the equipment reacted to the jam.

Example 3: You would like to image the launch of a missile. You have ample warning when ignition is to happen. There is a long count down. There may even be a signal available at launch time

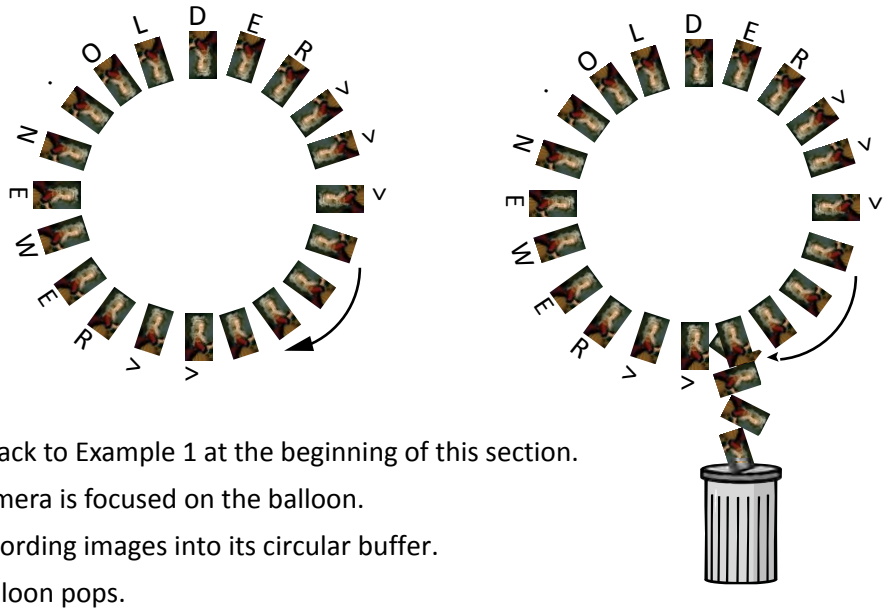
In order to capture events like the ones in the examples above, the TS3 uses a circular image buffer that is able to capture high speed imagery indefinitely, though it may only be able to retain a few seconds at a time. The figure below is a representation of a circular buffer. First the empty buffer is seen with 20 empty slots for images. The second graphic shows the first four frames. With each frame added, the older images are shifted up, the newest ones added at the bottom.

Figure 10-5: Circular Buffer Fills and Images Shift Position



Eventually, the circular buffer will fill up and overflow, but when it does, it continues to keep the newest images as it discards the oldest.

Figure 10-6: Circular Buffer Fills and Images Shift Position



Referring back to Example 1 at the beginning of this section.

- The camera is focused on the balloon.
- It is recording images into its circular buffer.
- The balloon pops.

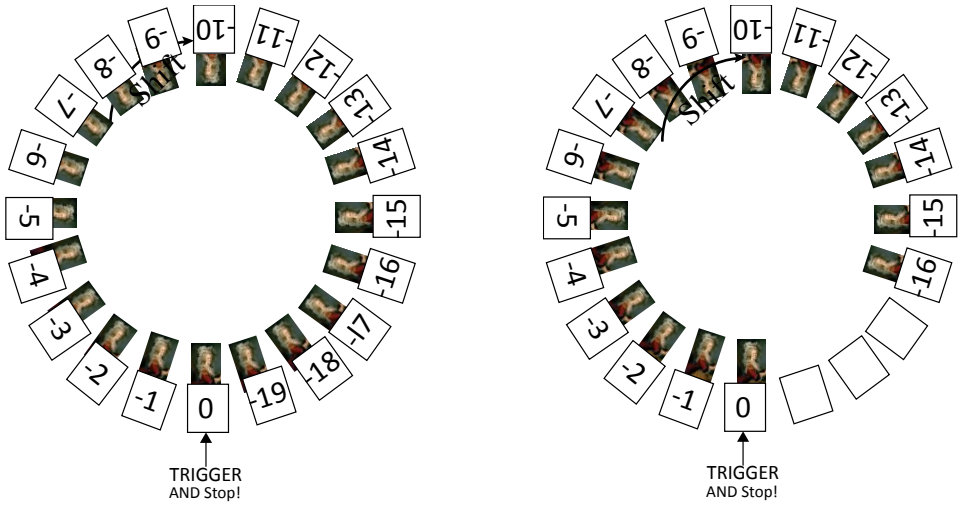
The camera has captured the event, now you just need to make the camera stop before the images are discarded. For this we use an **End Trigger**.

Note: In photography, the term “trigger” is often used in reference to the shutter--usually cameras are triggered to take one image. In high-speed video capture, we use the term in reference to controlling the acquisition of some (usually very large) number of video frames.

With the camera configured for an End Trigger the camera will fill its 20 frame circular buffer until it gets a Trigger from the Trigger Button on the top of the TS3, from a Trigger signal received on the Sync I/O connector, or from a software application. At that time it will Stop recording. The last frame recorded will be given the number “0.” All previous Frames will be given sequential negative numbers.

Played back, the resulting video begins on frame -19, progresses to frame 0, then stops. If the camera did not run long enough to fill its buffer, it would still stop when it received the trigger and the resulting video would be shorter, starting with a less negative number (#-16 in the graphic below).

Figure 10-7: Circular Buffer Overflowing



Referring back to Example 2 in the beginning of this section

- The TS3 is Recording the machinery running normally. It may be running for hours before anything interesting happens
- The machinery has a problem.
- A signal is sent in reaction to the problem.

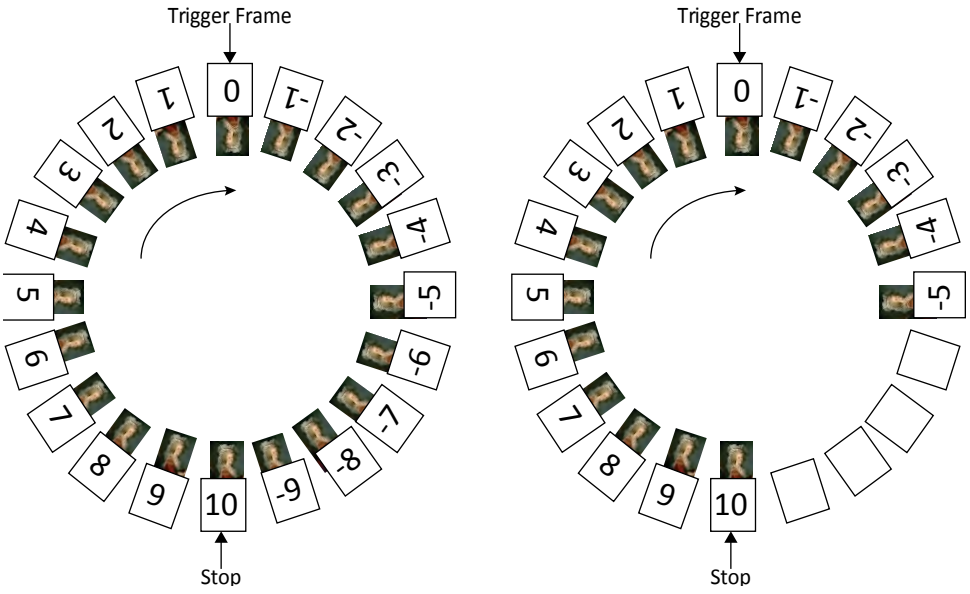
In this case, the camera needs to record the seconds before and after the problem is detected. The TS3 has the perfect trigger setting for this. The 50% Trigger divides the image capture into two halves, the images just before the trigger is received (**pre-trigger frames**), and the images immediately after the trigger is received (**post-trigger frames**).

Using the **50% Trigger** the TS3 fills the circular buffer until it sets the trigger. For the example here, there is a good chance it will be getting the trigger signal directly from the machinery to its Sync I/O connector, but it would work as well, triggered manually by a patient human.

When the TS3 is triggered, it keeps recording until it has captured the 1/2 the buffer's worth of post-trigger frames. The buffer now has a number of pre-trigger frames with negative frame numbers, frame "0" and post-trigger frames with positive numbers. When played, the video on the below left begins with frame #-9 and ends with frame #10.

If the camera is triggered before it has captured its full allotment of pre-trigger frames, it will still record 1/2 the buffer in post-trigger frames and stop. The video on the right begins with frame #-5 and ends with frame #10.

Figure 10-8: Circular Buffer End Trigger



Referring back to the 3rd example at the beginning of the section

- The TS3 is framed and focused on a missile about to launch.
- It begins recording well before launch time. But it is only required to capture the launch.
- There is a countdown. The TS3 receives its trigger electronically from launch control or manually.

In this case no video is required before time 0 of the launch. The trigger acts like a “start button” for the camera to begin saving captured video.

For this type of recording, the TS3 has a **Start Trigger**. Using the Start Trigger, when the TS3 gets a trigger it will record Frame 0, then fill the buffer with post-trigger frames. When played back the video will begin with Frame 0, then proceed with all positive frame numbers.

Selecting Other Trigger Values

More likely than using the Start Trigger for example 3, however, is to use a 5% or 10% Trigger. This affords you a cushion of safety in case there is a problem with the launch signal--giving you time to trigger manually. Also in the case that there is a problem in the launch sequence just before ignition, that would be captured as well.

The 10% trigger works just like the 50% trigger explained above, except that only 10% of the imagery is captured pre-trigger, and 90% is captured post-trigger.

Using FasMotion or the web-App, the trigger position can be placed anywhere by percentage or frame number. The TS3 on-display interface has Start, 10%, 50%, 90% and End options

Application Note 4: Frame Rate, Resolution, and Exposure

Scale and Resolution/Frame Rate

Selecting the proper resolution and frame rate for a given high-speed event is important. It is based on the Field of View (FOV) required to get a good image of your object of interest and the speed at which the object will move through that FOV.

For example, if you wish to image an automobile travelling at 50 mph across an intersection, full resolution and a relatively slow frame rate will work because your field of view (FOV) will be large and the car will not be moving through it very quickly.

Imaging a bird travelling at the same speed will require a much smaller FOV as the bird is 1/20th the size of the car. If you wish to use the same scale (object size/FOV), the FOV becomes 1/20th the size and the bird moves through it 20x as fast.

If you got acceptable imaging of an auto at 60FPS, it may take 1250FPS to get similarly acceptable imaging of a bird at moving the same speed.

Aliasing and Frame Rate

If you are imaging a motion that is cyclical in nature like a wheel spinning or a lever moving up and down, it is important to use a high enough frame rate to avoid motion aliasing. If you know the speed of the object, use a frame rate at least a few times as fast as the repetition rate to get a valid characterization of the motion. If you don't know the speed, use as high a frame rate as possible to start with and adjust from there. (Be sure to analyze the movement one frame at a time as the playback speed may cause aliasing as well.)

Generally you will choose to use the largest resolution possible for the frame rate required. This will give you the best definition of our object of interest. Smaller resolutions may be desired in order to increase the record time. Choosing the right shutter speed is dependent not only on the speed at which an object is travelling through the FOV, it is also dependent on how the imagery is going to be used.

For motion analysis it is best to get as short an exposure as possible in order to limit motion blur. (Motion blur an be defined as the number of pixels traversed by an edge of an object during an exposure.)

For smooth video, on the other hand, long exposures are best. These make for more attractive movies, but blurry stills.

Application Note 5: Optimizing System for Image Transfers

Transferring large volumes of image data from the camera to a computer over the Gigabit Ethernet connection can be very fast on an optimised system. For example, a full 8GB camera buffer will produce about 25GB of color TIFF files. An optimised high-performance system may transfer 25GB of full-resolution images from camera to PC in less than five minutes, while on an un-optimised system, the transfer could easily take more than an hour.

Several parameters contribute to file transfer performance:

- Network and PC hardware
- PC activity
- FasMotion setup
- Image file format and resolution

Network and PC Hardware

- Processor/Chipset type and speed: use fast multi-core processors, 64-bit system
- Memory capacity and speed: 4GB minimum. 8GB recommended
- Graphics card type speed and onboard memory: Graphics performance can throttle live and playback views, graphics cards without onboard memory will take system memory and slow things down
- NIC type and speed: NIC performance varies widely. Pick a Gigabit NIC that supports Jumbo Frames. We have found that some systems only perform well with Jumbo frames set to 9K, while others work well at 1500. This is a parameter that you may need to experiment with to get optimum results.
- Multiple Network interfaces may be available on a given PC. For optimum transfers, for best results you may wish to disable or disconnect all interfaces other than the one to be used with the camera during transfers.
- Hard Disk type: sustained transfer speed is most important drive attribute. Having a second drive on the system for image transfers is helpful--avoid using the drive that the OS and any program files are on. SATA II or III SSD or high-speed spinning media drives may be added internally or externally to your PC. If the PC has an eSATA port, consider connecting an SSD to it for image transfers.
- Disk state: fragmented disks and disks that are running out of space will slow transfers.

PC OS/Software

- Close all other applications, services, updaters, etc., including performance monitors such as WindowsTask Manager, Wireshark, HD Tune Pro, etc. while running FasMotion.
- File System format: On a Windows PC, use NTFS for the data drive.
- Do not index the target drive.
- PC Power Management: disable all, including sleep modes for PC and NIC
- Disable all Firewalls and Anti virus software! (You will not want the PC a ached to the any outside network including the Internet while connected to the camera.)
- 3rd party filter drivers: (disable using NIC’s properties page)

NIC Parameters

- Set Transmit/Receive buffers to maximum (these may also be referred to as descriptors)
- Jumbo Frames/Packets set to maximum size (usually 9K). Experiment with these settings as results to vary from system to system.
- Enable interrupt moderation / throttling (set to adaptive if available)
- Enable Checksum offloads

Camera Connection

- Point to point connection without any routers or switches between the camera and the computer is best. If you do need to use a Router or Switch, confirm that it supports and is configured for Gigabit Ethernet, UDP, and Jumbo Packets. Many Switches Some Routers have built-in firewalls- these will need to be disabled.
- Use Cat 5e or Cat 6 cables only. (Cat 5 cables do not support Gigabit Ethernet and may cause the system to run at 100Mb.)

Fas*M*otion Parameters

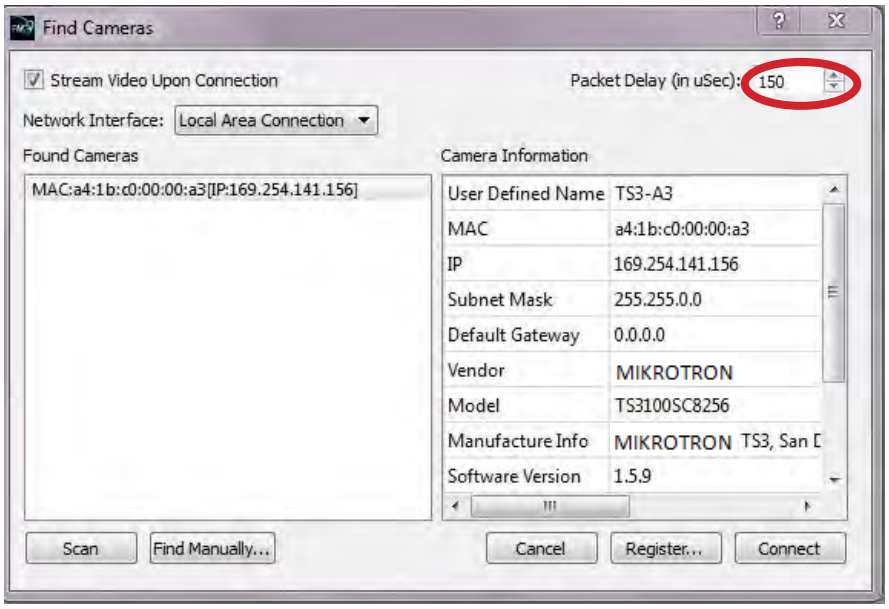
There are several parameters to be set to optimize performance. FasMotion Default Parameters are set conservatively so the application will run on an average un-optimized system. If your system is excessively slow or busy, you may need to change to more conservative settings. If you have optimized your system for image transfer performance, you will wish to change to more aggressive settings in order to get faster transfers.

UDP Transfers

The camera system, while controlled by Fas*M*otion, uses UDP protocol for all video streaming (Live and Playback) and for all file transfers.

If the camera is allowed to send image data and metadata as fast as it is able, it will easily swamp most systems and will cause the UDP connection to fail. The system introduces an inter-packet delay to slow the camera down to a level where the PC can keep up.

Figure 10-9: Packet Delay Spinner



Setting Packet Delay

The camera is The Packet Delay setting is found in the Find Cameras menu. This is a edit box/spinner that sets the inter-packet delay in µsec.

The default setting is 200. Very fast systems will be able to keep up with a delay of 10 to 20, while slow systems may need the setting bumped up to 300 or 400. For transfers of very large numbers of very small frames (tens of thousands of JPGs, for example, or possibly large numbers of low-resolution stacks of uncompressed images) the delay will also need to be increased in order to accommodate file-system overheads.

Transfer performance can be monitored by simply watching the progress bar during a Save or Copy. If you notice the progress stopping often or if the system needs to retrieve missing frames at the end of a transfer, that is a good indication that the PC is not keeping up and that the Packet delay needs to be increased.

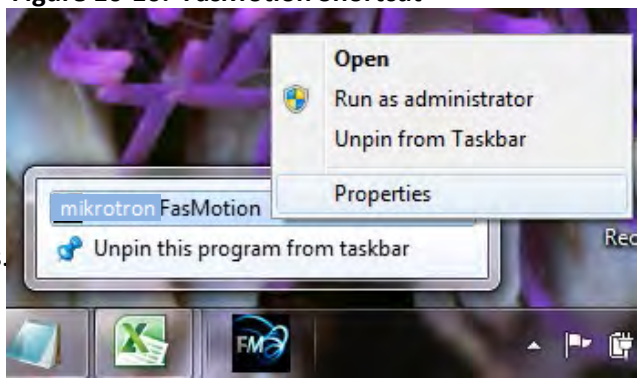
A better way to assess transfer performance is by setting the -s command-line switch and reviewing the stats.txt file after a transfer (see the next section)

Setting Command-Line parameters in Fas*M*otion.

Several of the operating parameters of FasMotion are set from the command line using arguments or switches. The easiest way to change these parameters is to edit a FasMotion short cut:

1. Select a shortcut for Fas*M*otion. This can be the desktop shortcut made by default during installation or one that you make manually after installation. You may wish to pin the Fas*M*otion shortcut to the task bar and use that shortcut.
2. Right-click on the selected FasMotion shortcut, then right-click again on "MIKROTRON FasMotion," and click on "Properties."
3. Arguments may be added to the "...\FasMotion FasMotion. exe" line to change application parameters.

Figure 10-10: Fas*M*otion Shortcut

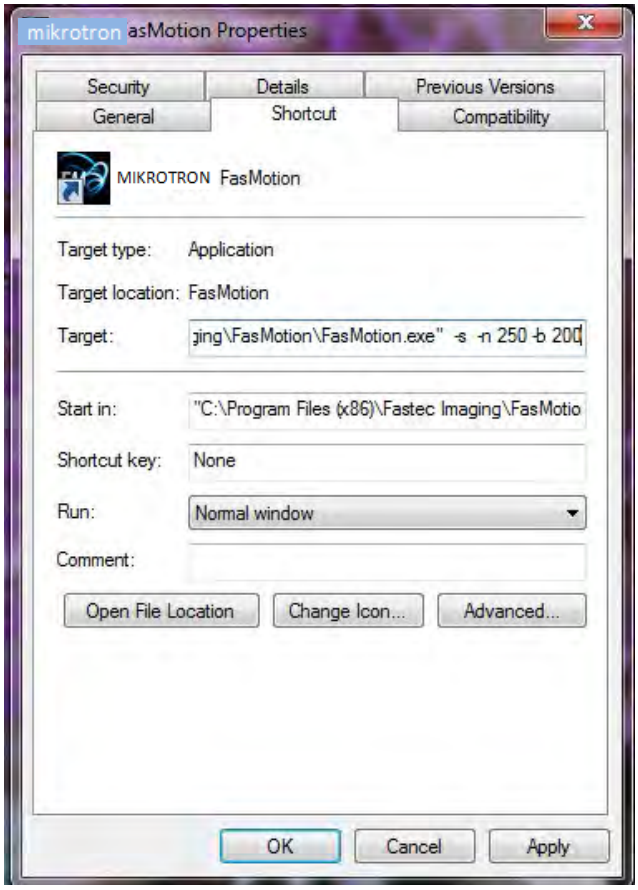


-S The "Stats" Switch

One important consideration in optimizing your system is how to compile results.

Adding "-s" to the command line as shown in Figure 10-11, tells Fas*M*otion to write a the file "S ats. txt" into your .../Documents directory. This creates one line of tab-delimited text for every Save or transfer done to PC media (such as Save or Copy to Path) by Fas*M*otion. Tab headers for this text file include:

Figure 10-11: Fas*M*otion Shortcut Properties



- **Duration -**total time of the transfer (h:m:s:decimal)
- **Bytes -** the number bytes transferred
- **Speed** - transfer speed in MB/s
- **Missed Frames** - frames missed in the first pass (these are retrieved at the end of the transfer)
- **Good Frames** - total number of frames transferred--this should match the number of frames in the clip
- **PktSize** -Packet Size (default is usually 1500, Jumbo frames may be up to 9000)
- **PktDlyBegin/End**--Packet Delay (the delay time in µsec set in the Camera Find window)
- **Buffer** - number of buffers reserved in PC memory
- **Backoff** - FasMotion keeps track of how much memory it is using for buffering images. If it uses more than the specified "Backoff ," it will tell the camera to stop sending image data until it catches up
- **Min**--Minimum Buffers (the minimum number of buffers FasMotion had in reserve during the transfer. If this number gets down to 0, you will see a number in the "Missed Frames" column and you will notice in the Save dialog that the system had to go back and retrieve missed frames after the first pass.)
- **Drv** -Drive (the target drive letter such as E: or C:)
- **Ext** -Extension (the file type saved)

Table 10-1 on page 105 is from an actual benchmark test of an optimized system. The performance, which included saves of full (8GB) camera buffers of all file types in 1280 x 1024, 1280 x 720, and 512 x 512 resolutions, is representative of a very fast purpose-built system. A raid array used for storage is capable of unusually high sustained transfer rates. Table 10-2 on page 105 is from a benchmark test of a moderate-performance system.

Table 10-1: Image Transfer Performace

Duration: h:m:s:dec	Bytes	Speed MB/s	Miss-Frames	ROI	Good-Frames	Pkt-Size	MissPkts	PktDly	Buffer	Backoff	Min	Drv	Ext
0:1:52:856	913889066	7.78172	0	1280x1024	6517	9000	0	20	250	125	244	E:	avi
0:2:24:731	8545872440	56.5971	0	1280x1024	6517	9000	0	20	250	125	227	E:	dng
0:4:44:3	25626251672	86.0532	0	1280x1024	6517	9000	0	20	250	125	124	E:	bmp
0:1:52:838	913889066	7.78172	0	1280x1024	6517	9000	0	20	250	125	245	E:	jpg
0:4:45:15	25627789684	85.7564	0	1280x1024	6517	9000	0	20	250	125	122	E:	ti
0:2:24:712	8543813068	56.5834	0	1280x1024	6517	9000	0	20	250	125	229	E:	ti
0:1:53:653	996320922	8.40855	0	1280x720	9269	9000	0	10	250	125	213	E:	avi
0:2:21:445	8547871800	57.8148	0	1280x720	9269	9000	0	10	250	125	226	E:	dng
0:5:6:405	25627450264	79.8701	0	1280x720	9269	9000	0	10	250	125	88	E:	bmp
0:1:53:630	996320922	8.40855	0	1280x720	9269	9000	0	10	250	125	231	E:	jpg
0:5:7:622	25629637748	79.6167	0	1280x720	9269	9000	0	10	250	125	89	E:	ti
0:2:21:446	8544942796	57.795	0	1280x720	9269	9000	0	10	250	125	221	E:	ti
0:5:8:805	25627450264	79.3514	0	1280x720	9269	9000	0	20	250	125	93	E:	bmp
0:1:55:323	1078091543	8.94042	0	512x512	32584	9000	0	20	250	125	196	E:	avi
0:2:27:543	8561250496	55.5418	0	512x512	32584	9000	0	20	250	125	72	E:	dng
0:7:13:126	25626924992	56.4428	0	512x512	32584	9000	0	20	250	125	84	E:	bmp
0:1:55:896	1078091543	8.94042	0	512x512	32584	9000	0	20	250	125	18	E:	jpg
0:7:13:978	25634614816	56.4598	0	512x512	32584	9000	0	20	250	125	63	E:	ti
0:2:26:260	8550953952	55.855	0	512x512	32584	9000	0	20	250	125	156	E:	ti

System: Intel i7-3770 CPU @ 3.40GHz
8.00GB RAM
ARECA (X86-64-STORPORT) SAS RAID (RAID6-ENGINE) (4 SSD drives)

- In the chart above, there are 3 sets of saves. Each line represents one save.
- The largest, uncompressed file types had the fastest transfer rates, but the longest transfer time
- Note that the Min (minimum buffers) get progressively smaller as the frame sizes got smaller and the number of frames increased. For 512 x 512 jpeg, the min value went down to 18. If the min value had gone to 0, the system would have begun missing frames and doing retries, greatly slowing things down. (For smaller resolutions a higher packet delay may be recommended)

Table 10-2: Table Stats.txt Moderate_Performance System

Duration h:m:s:dec	Bytes	Speed MB/s	Miss-Frames	ROI	Good-Frames	Pkt-Size	MissPkts	PktDly	Buffer	Backoff	Min	Drv	Ext
0:1:51:796	251596130	2.16163	0	1280x1024	6517	9000	0	110	300	150	295	C:	avi
0:3:52:273	8545872440	35.1292	0	1280x1024	6517	9000	0	110	300	150	237	C:	dng
0:8:38:916	25626251672	47.1797	0	1280x1024	6517	9000	0	110	300	150	146	C:	bmp
0:1:51:717	251596130	2.16163	0	1280x1024	6517	9000	0	110	300	150	289	C:	jpg
0:8:38:554	25627789684	47.1826	0	1280x1024	6517	9000	0	110	300	150	51	C:	ti
0:3:52:391	8543813068	35.1208	0	1280x1024	6517	9000	0	110	300	150	212	C:	ti

System: Intel i5-2400S CPU @ 2.50GHz
6.00GB RAM
ST31000524AS Drive: 7200 RPM spinning media SATA/SAS

Note: Installation of an additional drive, capable of high sustained transfer speeds can boost performance substantially. This same system was used for the downloads in “Table 10-5: Finding the Correct Packet Delay Value” on page 108, but those used an external target drive.

Reserving Memory for Fas*M*otion

FasMotion reserves some amount of PC memory when it starts. The default values is 200 “buffers”, which translates to about 1GB. On systems that have less than the 4GB recommended minimum installed memory, this value may be too high, while on systems with 6GB or 8GB of installed memory, the value may be bumped up for better performance. The argument for memory allocation is -n *x,* where *x,* represents the number of buffers (about 5MB each) to be used.

Examples:

To lower the memory allocation to 500MB:

“...\FasMotion\ FasMotion. exe” -n 100

To increase memory allocation to 1.5GB

“...\FasMotion\ FasMotion. exe” -n 300

Note: 300 buffers is the maximum Windows will allow.

Using Multiple switches:

If you are adding the -n switch, you will likely be using the -s “stats” switch as well. Multiple switches may be used, separated only by a space (the order does not matter):

“...\FasMotion\ FasMotion. exe” -n 300 -s

In “Figure 10-10: FasMotion Short cut” notice there are three memory arguments:

“...\FasMotion\ FasMotion. exe” -s -n 250 -b 200

The last argument is the backoff parameter.

Changing the “Backoff” Parameter

The -n x buffers are used to store incoming image data before being written to the target drive. This is done because the target drive will not read at a consistent rate, especially as it deals with file system overheads and other housekeeping tasks. The drive will tend to get a little behind, then catching up.

If the drive gets too far behind, the system may run out of buffers before it gets caught up. Fas***M***otion can tell the camera to stop temporarily while the system catches up, but it takes a while for that message to get to the camera, and there may be quite a few images already in the pipeline when the message is sent. FasMotion needs to send the message well before it runs out of buffers or it will start missing packets.

The default backoff is 1/2 the buffer value. If you have designated 200 buffers, the default backoff will be 100, meaning that when there are fewer than 100 buffers remaining, the system tells the camera to stop sending data for a while.

On a very fast system that has the packet delay set very low, the system will use its buffers very quickly, so it may be good to set the backoff to a value higher than the default. An example of the is the system used for “Table 10-2: Table Stats.txt Moderate_Performance System” on page 105. This system has 8GB of memory, is a dedicated system for camera downloads, and is operating with a very small packet delay. Notice that for some of the saves at 512 x 512, the Min (minimum buffers) goes quite low--one goes all the way down to 18. Had the all of the buffers been exhausted, the system would have missed frames and lost a lot of time with retries.

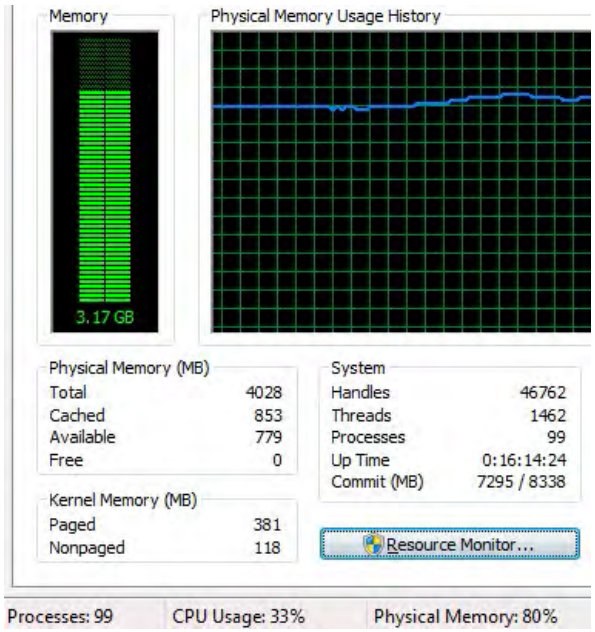
One way to avoid this would be to change the packet delay to a higher number. Another way to avoid this would be to set the buffers up higher (there is plenty of RAM available) and set the backoff higher as well, so the system has a little more time to recover when it gets a little behind

“...\FasMotion\ FasMotion. exe” -s -n 300 -b 200

When the PC is Too Busy:

Referring to Table 10-3, you will notice that for several of the transfers there are missing frames and packets. These were downloads of only 188 frames, which should be very easy considering that FasMotion reserved 250 buffers--more than enough to buffer the entire transfer. The Min (minimum buffers) never got close to the Backoff number , so the Fas*M*otion never got a chance to slow the camera down before it started missing frames.

Figure 10-12: Memory Usage in Task Manager



To understand what happened here, it is helpful to look at the performance tab in Task Manager. Notice in Figure 10-12 that the "Free" memory has gone to 0. This means that, having no more physical memory, the system is going to slow down. It will not be able to service the application properly.

What is happening here is that the system is very busy. To create this example, the computer used had about a dozen applications open.

It is common to have a lot of applications and services running "in the background" on a computer. In order to get consistent high-speed file transfers from Fas*M*otion it is very important to have as little else running on the PC as possible.

Note: In each instance on the table, all of the frames were successfully saved as the system automatically retrieves any "missed frames" at the end of the download.

Table 10-3: Missing Frames on a Busy System

Duration h:m:s:dec	Bytes	Speed MB/s	Miss-Frames	ROI	Good-Frames	Pkt-Size	MissPkts	PktDly	Buffer	Backoff	Min	Drv	Ext
0:0:6:650	26573616	4.22376	0	1280x1024	188	1500	0	180	250	125	236	C:	AVI
0:0:33:468	246528160	7.12447	0	1280x1024	188	1500	0	180	250	125	247	C:	DNG
0:1:40:407	739256608	7.0501	5	1280x1024	188	1500	9708	180	250	125	248	C:	BMP
0:0:7:611	26563368	3.61897	3	1280x1024	188	1500	280	180	250	125	216	C:	JPG
0:1:41:698	739300976	6.98072	5	1280x1024	188	1500	5354	180	250	125	247	C:	TIF
0:0:33:951	246468752	7.12276	1	1280x1024	188	1500	578	180	250	125	247	C:	TIF

Use Jumbo Packets!:

Referring to Table 10-4, using Jumbo Packets (sometimes called Jumbo Frames) can make a big difference. You may find that a larger packet delay is required with Jumbo Frames, but because the packets are bigger, there are fewer of them, and fewer delays as well.

In this example there was about a 3x improvement in transfer rate simply by using Jumbo Packets.

Table 10-4: Benefit from Jumbo Packets

Duration h:m:s:dec	Bytes	Speed MB/s	Miss-Frames	ROI	Good-Frames	Pkt-Size	MissPkts	PktDly	Buffer	Backoff	Min	Drv	Ext
0:0:28:484	484259096	16.4938	0	1280x960	394	1500	0	40	200	100	196	F:	ti
0:0:28:156	484259096	16.4938	0	1280x960	394	1500	0	40	200	100	195	F:	ti
0:0:9:438	484259096	51.3139	0	1280x960	394	9000	0	40	200	100	182	F:	ti
0:0:26:734	1317578048	48.3285	0	1280x960	1072	9000	0	40	200	100	105	F:	ti
0:0:47:203	2443418992	49.5793	0	1280x960	1988	9000	0	40	200	100	190	F:	ti

Finding the Correct Packet Delay Value:

The correct packet delay value is one where the PC can keep up with the flow of incoming packets. The use of the buffer will sometimes mask the act that the drive is not quite keeping up.

Referring to Table 10-5, compare the Min column (that is the minimum number of buffers available during the save) with the “Good Frames” column (the number of frames saved). You can see that as the number of frames increases, the Min number decreases, which means that the hard drive is not quite keeping up with the flow.

Note: In each instance on the table, all of the frames were successfully saved as the system automati ally retrieves any “missed frames” at the end of the download.

Table 10-5: Finding the Correct Packet Delay Value

Duration h:m:s:dec	Bytes	Speed MB/s	Miss-Frames	ROI	Good-Frames	Pkt-Size	MissPkts	PktDly	Buffer	Backoff	Min	Drv	Ext
0:0:14:663	1179664800	80.3583	0	1280x1024	300	9000	0	40	200	100	178	K:	bmp
0:0:19:266	1572886400	78.9485	0	1280x1024	400	9000	0	40	200	100	174	K:	bmp
0:0:23:562	1966108000	81.5229	0	1280x1024	500	9000	0	40	200	100	168	K:	bmp
0:0:28:242	2359329600	80.3583	0	1280x1024	600	9000	0	40	200	100	161	K:	bmp
0:0:41:923	3538994400	82.3182	0	1280x1024	900	9000	0	40	200	100	152	K:	bmp
0:0:56:45	4718659200	80.3583	0	1280x1024	1200	9000	0	40	200	100	130	K:	bmp
0:1:10:535	5898324000	80.3583	0	1280x1024	1500	9000	0	40	200	100	105	K:	bmp
0:1:33:768	7864432000	80.6463	0	1280x1024	2000	9000	0	40	200	100	99	K:	bmp
0:2:19:27	11796648000	80.9364	0	1280x1024	3000	9000	0	40	200	100	99	K:	bmp
0:5:13:731	25626251672	78.0802	1	1280x1024	6517	9000	40	40	200	100	99	K:	bmp
0:5:15:858	25626251672	77.5844	0	1280x1024	6517	9000	0	**50**	200	100	**188**	K:	bmp
0:5:16:5	25626251672	77.3389	0	1280x1024	6517	9000	0	35	200	100	99	K:	bmp
0:5:16:338	25626251672	77.3389	0	1280x1024	6517	9000	0	25	200	100	96	K:	bmp

The last three downloads shown on the table demonstrate that a higher Packet Delay is a little better for this system. In these last three saves, delays of 50, 35, and 25 were used. You can see that the speed of the transfer was not really affected by the increased delay times, but that the Min buffer value was very high. For this system a Packet Delay of 40 will probably be OK, but 50 is a be er number because the system can maintain the same transfer rate without exhausting its buffers.

Application Note 6: Choosing an Image File Format

TS3 and TS3 cameras are capable of outputting images in 7 different file formats. These format serve different purposes depending on imaging and work flow requirements.

JPEG images are compressed in order to take the least space. A recording saved as JPEGs results in an image stack, whereby each frame is a file. JPEG compression quality (0-100, with 100 being highest quality, lowest compression) may be selected by the user in the camera User Preferences menu. Default “JPEG Qfactor” is 80, which results in compression of 10:1 to 20:1 for average scenes.

AVI files a e basically JPEGs placed in a “wrapper,” resulting in one video file that is playable on many popular video players.

BMP and TIF files a e almost identical--both being uncompressed, fully processed images. Like JPEGs they are saved as stacks, but are much larger.

DNG, TIF(raw), and CAP files are raw formats, meaning that color images are not interpolated. Color interpolation takes 8-bit images and colorizes them, which produces 24-bit files 3x as large. DNG and TIF(raw) files are smaller than BMP and TIF files. DNG and TIF(raw) are stacks, while CAP files contain a whole “Session” of images.

- JPEG: JPEG compressed, user selectable compression, saved as video stacks. All image and color processing done on camera. 8-bit data only is preserved so output is 8-bits/pixel mono, or 24-bits/pixel color.*
- AVI: Motion JPEG compressed, user selectable compression, user selectable playback rate, saved as one file. All image and color processing done on camera. 8-bit data only is preserved so output is 8-bits/pixel mono, or 24-bits/pixel color.*
- DNG: Not compressed, raw format with “as shot” parameters saved within images. 8-bit or 10-bit data preserved (for producing 24-bit or 30-bit color images). Available on color cameras only. All image processing excluding FPN correction, but including color interpolation, brightness, contrast, gamma, color gains, etc. to be done off-camera in 3rd-party software. Compatible with Adobe an Black Magic imaging software. 8-bit images saved 8 bits/pixel; 10-bit images saved 16 bits/pixel
- BMP: Not compressed. Saved as video stacks. Bitmap. All image and color processing done on camera. 8-bit data only is preserved so output is 8-bits/pixel mono, or 24-bits/pixel color.*
- TIF: Not compressed. Saved as video stacks. Almost identical in size and specification to BMP, but has added “TIFF tags.” All image and color processing done on camera. 8-bit data only is preserved so output is 8-bits/pixel mono, or 24-bits/pixel color.*
- TIF (raw) Not compressed. Saved as video stacks. 8-bit or 10-bit data preserved (for producing 24-bit or 30-bit color images and 8-bit or 10-bit mono images). 8-bit data is saved as uninterpolated 8-bit images. 10-bit data is saved as uninterpolated 16-bit images. Similar to DNG format, except that the “as shot” values must be parsed from the metadata files (not written into the image files)
- CAP: Proprietary MIKROTRON “partition capture” image format. Raw image data from sensor is saved in a file along with FPN correction (black frame), as well as “as shot” parameters. 8-bit or 10-bit data is preserved. CAP files may be loaded back into camera image memory, then saved again to any media in any of the other formats.

*Note: When 10-bit data is recorded, all 10 bits are used in the 16-bit image processer. For formats that only save 8-bit data, this means that all of the image processing done still uses all of the 10-bit data and there still may be a discernible (certainly a measurable) difference in the 8-bit processed images produced. (If you capture both 10-bit and 8-bit images of the same scene, then save them as 8-bit color images, the ones captured in 10 bits will have a higher number of discrete colors than those captured in 8 bits.

Table 10-6: File Format Features

Format	Processing	Size @1280 x 1024		Pro	Con
		8-bit	10-bit		
JPG	JPEG Compression Color Interpolation Brightness, Contrast, Gamma, Gains, FPN*	241K (color)		• Small • Popular still format • Easy analysis	• Degrades with re-processing • Huge folders full of file
AVI	JPEG Compression Color Interpolation Brightness, Contrast, Gamma, Gain, FPN*	241K (color)		• Small • Popular video format • Nice 1-file archive format	• Degrades with re-processing
DNG	FPN*, ("As-shot" parameters** saved-not processed)	1281K (raw)	2561K (raw)	• Maintains highest image fidelity • All bits saved in 10-bit mode • Compatible with high-quality image and video production tools • Compact vs BMP/TIF	• Huge folders full of file
BMP	Color Interpolation Brightness, Contrast, Gamma, Gains, FPN*	3841K (color)		• Good image fidelity • Compatible with popular imaging tools	• Huge folders full of file
TIF	Color Interpolation Brightness, Contrast, Gamma, Gains, FPN*	3841K (color)		• Good image fidelity • Compatible with popular imaging tools	• Huge folders full of file
TIF(r)	FPN* only	1281K (raw)	2561K (raw)	• Maintains highest image fidelity • All bits saved in 10-bit mode • Compact vs BMP/TIF	• Huge folders full of file
CAP	None (black frame and "As-shot" parameters** saved)	1291K (raw)	1725K (raw)	• Maintains highest image fidelity • Only format that can be played back by the camera • 1-file format • Fastest Saves to SSD • Convert to any other format via the camera	• Proprietary format

*FPN: FPN correction is user-selectable. If FPN is set to Column, the correction is at the sensor-level and is asserted for all file types. If it is set to Off/Disabled, there will be no correction in any format. If it is set to Pixel, the black frame will be subtracted in all formats except for CAP. For CAP files, the black frame is copied into the CAP file and the correction is asserted when creating image data display and conversion.

** "As-shot" parameters: all image processing parameters, including color corrections, gains, brightness, contrast, and gamma are saved, but not asserted (pixel values are not manipulated). This allows for post-processing of the original pixel data.

Table 10-7: Save to SSD Benchmarks

	1280x1024 10-bit		1280 x 1024 8-bit		1280x720 10-bit		1280x720 8-bit		512x512		256x256	
Save to SSD	Rate MB/s	Images /s	Rate MB/s	Images /s	Rate MB/s	Images /s	Rate MB/s	Images /s	Rate MB/s	Images /s	Rate MB/s	Images /s
CAP	104.46	84.64	104.37	62.56	125.34	142.58	118.01	100.60	115.65	458.86	103.35	1652.59
DNG	52.47	41.96	100.14	40.05	44.22	50.28	83.53	47.50	15.16	60.05	3.21	50.92
BMP	127.32	33.95	127.57	34.02	109.17	41.40	109.35	41.47	45.80	60.58	9.77	52.09
JPG	4.34	27.64	2.40	27.25	1.65	27.90	1.06	28.05	1.42	37.96	0.45	35.58
TIFF	127.25	33.93	126.91	33.84	109.22	41.42	108.48	41.14	45.27	59.87	9.77	52.01
TiFF(r)	52.37	41.89	100.43	40.17	43.90	49.93	83.29	47.37	15.13	59.97	3.24	51.63